TM 11-818

WAR DEPARTMENT TECHNICAL MANUAL

RADIO TRANSMITTERS 33A AND 34A

RESTRICTED. DISSEMINATION OF RESTRICTED MATTER. No person is entitled solely by virtue of his grade or position to knowledge or possession of classified matter. Such matter is entrusted only to those individuals whose official duties require such knowledge or possession. (See also paragraph 23b, AR 380–5, 15 March 1944.)

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WAR DEPARTMENT,
WASHINGTON 25, D. C., 5 JANUARY 1945.

TM 11–818, Radio Transmitters 33A and 34A, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,
Chief of Staff.

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General.

DISTRIBUTION:
IBn 1(2); IC 11(5).
(For explanation of symbols see FM 21–6.)

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DESTRUCTION NOTICE

WHY —To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW —1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut—Use axes, handaxes, machetes.

3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives—Use firearms, grenades, TNT.

5. Disposal—Bury in slit trenches, fox holes, other holes. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Smash—Variable capacitors, tubes, relays, coils, fuses, meters, transformers, switches, crystals, insulators, tuning controls.

2. Cut—All wires, cables, coils, antennas.

3. Burn—All equipment and all associated training, technical, and installation manuals.

4. Bend or break—Brackets, chassis, shields, panels.

5. Bury or scatter—All remains, after destroying their usefulness.

DESTROY EVERYTHING

SAFETY NOTICE

This equipment uses high voltages which are dangerous and may be FATAL if contacted by operating personnel. Mercury-vapor rectifier tubes in these sets produce 700-volt and 1,600-volt plate supply to vacuum tubes. Use extreme caution when making adjustments while the set is in operation. Make sure that the control switches on the front are OFF before changing vacuum tubes or other plug-in parts. The main line switch to the power supply source should be open during repair or routine maintenance operations.

FIRST AID FOR ELECTRIC SHOCK

RESCUE. In case of electric shock, shut off the high voltage at once and ground the circuits. If the high voltage cannot be turned off without delay, free the victim from contact with the live conductor as promptly as possible. Avoid direct contact with either the live conductor or the victim's body. Use a dry board, dry clothing, or other nonconductor to free the victim. An ax may be used to cut the high-voltage wire; however, be watchful of electric flashes which may be disastrous.

SYMPTOMS.

a. Breathing stops abruptly in electric shock if the current passes through the breathing center at the base of the brain. If the shock has not been too severe, the breathing center slowly recovers and normal breathing is resumed, if a sufficient supply of air has been furnished meanwhile by artificial respiration.

b. The victim is usually very white or blue. The pulse is very weak or entirely absent and unconsciousness is complete. Burns are usually present. The victim's body may become rigid or stiff in a few minutes. This condition is due to the action of electricity and is not to be considered rigor mortis. Artificial respiration must continue to be given, as several such cases are reported to have recovered. The ordinary and general tests for death should never be accepted.

TREATMENT. Start artificial respiration immediately. At the same time send for a doctor if assistance is available. Do not leave the victim unattended. Perform artificial respiration at the scene of the accident, unless the victim's or operator's life is endangered from such action. *In this case only,* remove the victim to another location, but no farther than is necessary for safety. If the new location is more than a few feet away, artificial respiration should be given while the victim is being moved. During transportation, other methods of resuscitation may be used, if the method of transportation prohibits the use of the prone pressure method. Pressure may be exerted on the front of the victim's diaphragm, or the direct mouth-to-mouth method may be used. Artificial respiration, once started, must be continued, without loss of rhythm.

a. *Lay the victim in a prone position,* one arm extended directly overhead and the other arm bent at the elbow so that the back of the hand supports the head. The face should be turned away from the bent elbow so that the nose and mouth are free for breathing (fig. I ① and ②).

b. *Open the victim's mouth* and remove any foreign bodies, such as false teeth, chewing gum, or tobacco. The mouth should remain open, with the tongue extended. Do not permit the victim to draw his tongue back into his mouth or throat.

c. *If an assistant is available* during resuscitation, he should loosen any tight clothing to permit free circulation of blood and to prevent restriction of breathing. He should see that the victim is kept warm by applying blankets or other covering, or by applying along the sides of body and insides of legs hot rocks, or bricks wrapped in cloth or paper to prevent injury to the victim. The assistant should also see that the victim does not swallow his tongue. He should wipe from the victim's mouth any frothy mucus or saliva that may collect and interfere with respiration.

d. The resuscitating operator should *straddle the victim's thighs,* or one leg, in such a manner that:

(1) The operator's arms and thighs will be vertical while applying pressure first above the small of the victim's back (fig. I ③).

(2) The operator's fingers are in a natural position on the victim's back with the little finger lying on the last rib.

(3) The heels of the hands rest on either side of the spine as far apart as convenient without allowing the hands to slip off the victim (fig. I ①).

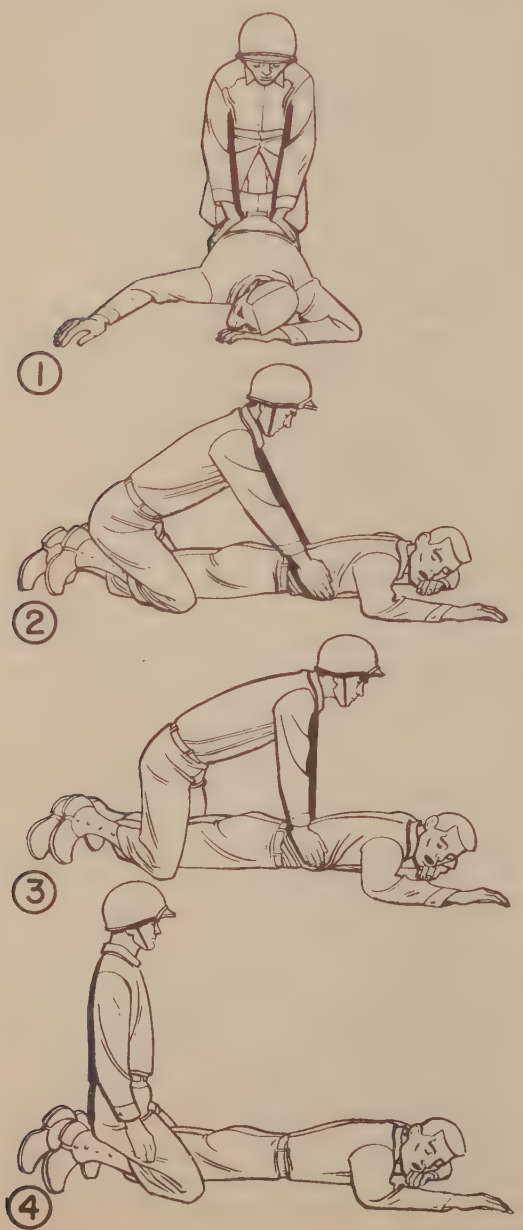
(4) The operator's elbows are straight and locked.

e. The *resuscitation procedure* is as follows:

(1) Exert downward pressure, not exceeding 60 pounds, for 1 second.

(2) Swing back, suddenly releasing pressure, and sit on the heels (fig. I ④).

(3) After a 2-second rest, swing forward again, positioning the hands; apply pressure for another second (fig. I ② and ③).



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f. The *counting* must be rhythmic, the forward swing, positioning of the hands, and the downward pressure should be accomplished in one continuous motion which requires 1 second. The release and backward swing require 1 second. The addition of the 2-second rest makes a total of four seconds for a complete cycle. Until the operator is thoroughly familiar with the correct cadence of the cycle, he should count the seconds aloud, speaking distinctly and counting evenly in thousands. Example: *one thousand and one, one thousand and two, one thousand and three, one thousand and four;* repeat. This method of counting insures accurate timing. The exact frequency of the operating cycle of resuscitation is of utmost importance.

g. Artificial respiration should be *continued without interruption* until the victim regains normal breathing or until pronounced dead by a medical officer. It may be necessary to continue resuscitation for several hours. For this reason relief operators should be used if available.

METHOD OF RELIEVING OPERATOR. The relief operator kneels beside the operator, assuming the same position on an imaginary victim, and follows the operator through three or four complete cycles. When he is sure that he has the correct rhythm, on the next forward swing of the operator the relief operator places his hands on the top of the operator's hands without applying pressure. This indicates to the operator that the relief operator is ready to take over. On the backward swing, the operator moves off the victim, to the side, and the relief operator takes the position of the operator. On the next forward swing, the operator being relieved assumes the position on an imaginary victim beside the new operator, and follows through two or three complete cycles with the new operator until he is sure that the new operator has the correct rhythm. The operator being relieved remains alert to take over instantly if the new operator falters or hesitates on the cycle. During the process of relief, the original operator counts aloud, by thousands, to give the relief operator the correct timing.

INHALANT STIMULANTS. If an inhalant stimulant is used, such as aromatic spirits of ammonia, the individual administering the stimulant should first test it himself to see how close he can hold the inhalant to his own nostrils for comfortable breathing. Be sure that the inhalant is not held too close to the victim's nostrils; keep it there only for short duration, 1 or 2 seconds every minute.

LIQUID STIMULANTS. After the victim has regained consciousness, he may be given a glass of water with ½ teaspoon of aromatic spirits of ammonia added, or hot coffee or hot tea as a stimulant. DO NOT GIVE AN UNCONSCIOUS VICTIM ANY LIQUIDS.

CAUTIONS.

a. After the victim revives, keep him lying quietly. Do not allow him to get up and walk even though he may feel that he is strong enough. Any injury which a person might have received, including electric shock, may bring about a condition of shock or fainting. This condition should be guarded against at all times. Shock is present if the victim is pale and has a cold sweat. His pulse is weak and rapid and his breathing is short and gasping.

b. Keep the victim lying flat on his back, with his head lower than the rest of his body, and his hips and legs elevated. Be sure that there is no tight clothing to restrict the free circulation of blood or hinder natural breathing. Keep him warm and quiet.

c. A resuscitated victim may suddenly stop breathing and require additional artificial respiration. For this reason, he must be watched carefully. NEVER LEAVE A RESUSCITATED PERSON ALONE UNTIL IT IS *CERTAIN* THAT HE IS FULLY CONSCIOUS AND BREATHING NORMALLY.

SECTION I
DESCRIPTION

1. GENERAL.

a. Purpose. (1) Radio Transmitter 33A is a two-channel, high-frequency radio telephone and telegraph transmitter for point-to-point, aeronautical ground station, and similar applications. It delivers a carrier power of 350 watts (w) into a suitable antenna in the frequency range (from 3 to 13 megacycles [mc]). It can be completely modulated for voice transmission, and provides facilities for continuous-wave (c-w) and two-tone telegraph transmission. Radio Transmitter 34A is the same as Radio Transmitter 33A, except for the audio-frequency panel which is replaced by a panel containing necessary conversion circuit elements. Radio Transmitter 34A can be used in applications where the transmission of c-w and two-tone signals only is required. These transmitters are designed so that one can be converted to the other by interchanging the audio-amplifier panel on Radio Transmitter 33A with the voltage divider panel on Radio Transmitter 34A.

(2) Two-tone telegraph, as referred to in this manual, is a system of printing telegraph operated by shifting the r-f carrier 850 cycles (c) under control of the telegraph terminal equipment. This is decoded by a telegraph receiver which uses frequency discrimination to translate the carrier into marking and spacing signals.

b. Specification Data. The characteristics of the two transmitting equipments are summarized as follows:

Characteristics	*Radio Transmitter 33A*	*Radio Transmitter 34A*
R–f power output	350 w	350 w
Modes of operation	Phone, c–w, and two-tone telegraphy	C–w and two-tone telegraphy
Frequency range	3 to 13 mc	3 to 13 mc
No. of preset channels	2	2
Type of oscillator	Crystal-controlled	Crystal-controlled
Crystal holder	Crystal Holder FT–249 (crystal in position A)	Crystal Holder FT–249 (crystal in position A)
Crystal frequencies	2.25 to 4.5 mc	2.25 to 4.5 mc
Type of modulation	Amplitude, high level	Amplitude, high level
Audio-frequency input level	35 db below 6 mw	
Audio-frequency response	± 2 db from 300 to 3,000 c	
Audio distortion	Less than 5% with 80% modulation	
Antenna impedance	70 to 600 ohms balanced or unbalanced line	70 to 600 ohms balanced or unbalanced line
Remote operation, loop resistance:		
Master control	100 ohms, maximum	100 ohms, maximum
Channel control	100 ohms, maximum	100 ohms, maximum
C–w telegraph	1,000 ohms, maximum	1,000 ohms, maximum
Two-tone telegraph	5,800 ohms, approximate	5,800 ohms, approximate
Power source	200–250 v a–c, 50–60 c, single-phase	200–250 v a–c, 50–60 c, single-phase
Power input:		
Standby	1,100 va, 1,000 w	900 va, 800 w
Full carrier, unmodulated	1,600 va, 1,500 w	1,500 va, 1,400 w
Full carrier, speech-modulated	2,000 va, 1,800 w	

Figure 1. Radio Transmitters 33A and 34A, front view. TL 11016

c. Construction. Front views of the Radio Transmitters 33A and 34A are shown in figure 1, and a rear view with the air filter mounted in place is shown in figure 2.

(1) The transmitter is self-contained in a black metal, welded steel frame cabinet. There are five panel units attached to the frame by screws on the front and supported by brackets from the sides of the cabinet. These units are interconnected by cables. The wires are attached to the terminal strips by screw connections. A rear door provides access for changing tubes and other plug-in parts, and for inspecting the equipment inside the cabinet. The door is equipped with a safety switch which removes all high voltage when it is opened. A motor-driven fan and spun glass air filter are mounted in the rear door to provide a circulating air current through the set for cooling purposes.

(2) The over-all dimensions of Radio Transmitter 33A, including the handset and ventilating fan assembly, are 22¾ inches wide, 69¾ inches high, and 25¼ inches deep. Make provision for a clearance of at least 4 feet in the rear of the transmitter for opening the door and replacing plug-in parts. These dimensions and other information relative to the installation of the set are shown in figure 27. The outline dimensions are the same for Radio Transmitter 34A, except that no handset is provided on the front of the set.

d. Radio-frequency Circuits. (1) The radio-frequency circuits consist of a crystal-controlled oscillator followed by two amplifiers, which also serve at times as frequency doublers, and a power amplifier. The power amplifier uses two 813 tubes in parallel. Crystals Y1 and Y2 used with this equipment are of the low temperature coefficient type, and require no heater or thermostat. Two-tone telegraph transmission involves an 850-cycle shift in carrier frequency without change in amplitude. The spacing period of the telegraph signal is the lower carrier frequency. The frequency shift is effected by placing a small variable air capacitor in parallel with the crystal by means of a diode rectifier, which functions as an electronic switch.

(2) The frequency range of the transmitters is divided into four bands as follows: 3.0 to 4.5 mc, 4.5 to 6.0 mc, 6.0 to 9.0 mc, and 9.0 to 13.0 mc. The four bands are referred to for the purposes of these instructions as bands A, B, C, and D, respectively. On band A the crystal frequency is amplified through both r-f amplifier stages. On bands B and C the crystal frequency is doubled by the second amplifier stage, and on band D the crystal frequency is doubled by the first amplifier

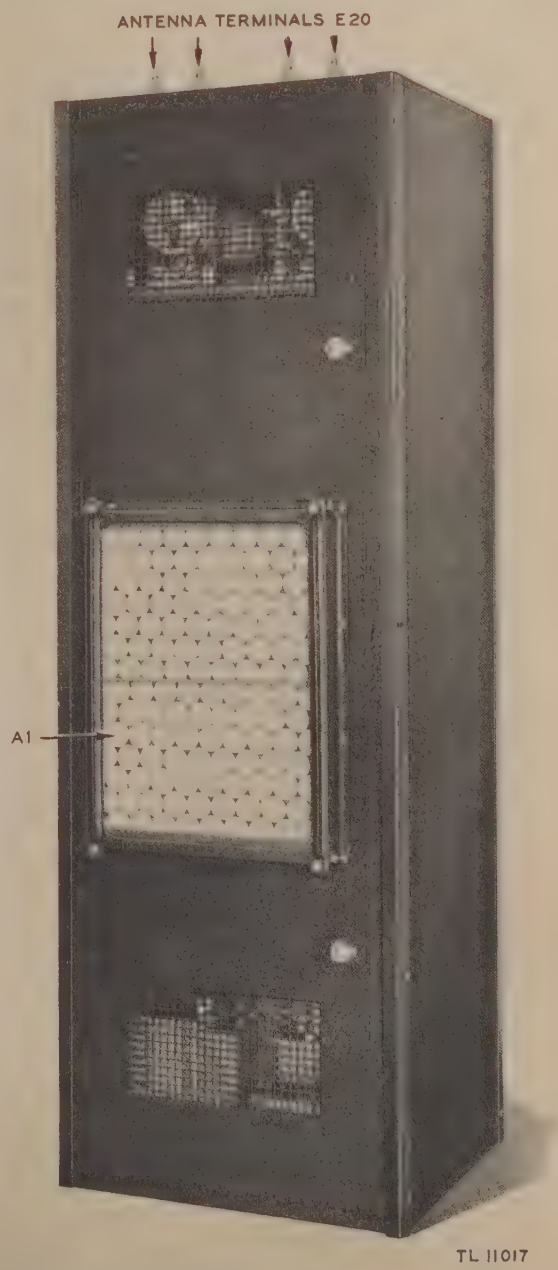


Figure 2. Radio Transmitter 33A or 34A, rear view.

stage and redoubled by the second amplifier stage. Excitation controls and band switches are provided for adjusting the plate voltages of the first and second amplifiers to attain the proper driving voltages for the succeeding stage, whether amplifying or doubling. The r-f power amplifier stage operates straight through at all frequencies. The crystal frequency will have the following relation to the carrier frequency:

Crystal frequency equal to:	
Carrier frequency, for carrier frequency	3.0-4.5 mc
½ carrier frequency, for carrier frequency	4.5-9.0 mc
¼ carrier frequency, for carrier frequency	9.0-13.0 mc

(3) R-f tuned circuits and adjustments are furnished in duplicate as channel 1 and channel 2. The desired channel is selected by relays controlled by the CONTROL switch on the front panel of the transmitter or by a similar switch at a remote position. Either channel may be operated at any frequency in the range of the transmitter independently of the frequency of the other channel.

(4) To effect 100 percent modulation in the r-f power amplifier tubes in Radio Transmitter 33A, the screen as well as the plate voltage is modulated. Modulation of the fixed screen voltage supply is accomplished by means of a separate winding on the modulation transformer.

e. Antenna System. (1) These transmitters are designed to work primarily into a balanced antenna, such as a doublet or rhombic, having a 600-ohm resistance. The r-f power amplifier is coupled to the antenna by means of an adjustable coupling coil inside the plate coil. While a 600-ohm termination is preferred, these transmitters are capable of being operated into a wide range of antenna resistance. No provision is made in the transmitters for tuning out any reactive component of the antenna or for an antenna current indicator. The output circuit for each channel may be connected to the input end of a transmission line or feeder by a pair of terminal posts on the top of the unit.

(2) The type of antenna chosen depends on the frequency used, the purpose for which the transmitter is used, and the location of the transmitting site with respect to the receiving site. The normal communication range is influenced by several of these factors. At 3 mc, the ground wave range may be more than 100 miles for average terrain, or perhaps two or three times as great over sea water, with the proper antenna. At the high end of the frequency range, absorption of the ground wave makes it necessary to rely on sky wave transmission.

f. Audio-frequency Circuits. (1) The audio amplifier forming a part of Radio Transmitter 33A has three push-pull stages: volume limiting amplifier, intermediate amplifier, and Class AB_1 modulator. Inverse feedback is included between the last two stages. With no speech applied or with relatively low level input, the volume limiter adjusts the amplifier to full gain. When the speech voltages developed in the windings of the modulation transformer are sufficiently high to modulate the carrier completely, a small amount of speech current from a winding of the transformer is rectified by a volume limiting rectifier tube. A time constant resistor and capacitor are connected in the output circuit of the rectifier. The d-c voltage developed across this resistor is applied to the control and mixer grids of the volume limiting amplifier. Any further increase of the speech level at the modulation transformer produces a higher bias for the volume limiter and consequently reduces the gain of this stage.

(2) A handset equipped with a carbon microphone, is mounted on the front of the audio amplifier panel. The transmitter may be modulated by means of this handset microphone or from a remote control station. Operation of the press-to-talk button in the handset handle operates the carrier control relay and closes the d-c supply circuit to the handset microphone.

g. Control Circuits. The transmitter may be operated on telephone or c-w telegraph by controls on the front panel, or it may be operated from a remote location by control circuits illustrated in figure 29. Two-tone telegraph operation requires the use of external telegraph equipment in either case. The operating controls on the transmitter include the main POWER switch, the EMISSION switch, the CONTROL switch, the TEST KEY, and the handset.

(1) The main POWER switch in the OFF position disconnects all power to the transmitter. In the ON position it supplies power to a 30-volt rectifier for relay operation and connects the main power supply to the armature of the power control relay. This switch must be left in the ON position for remote control operation of the set.

(2) The EMISSION switch has three positions, TWO TONE, PHONE CW, and EXT. OSC., and must be set at the proper position at the transmitter for local or remote operation. It must be set at EXT. OSC. when the transmitter is used with an external oscillator. In this position, two-tone telegraph operation cannot be used. This switch must be set at TWO TONE when two-tone telegraph transmission is used, and should be set at PHONE CW for telephone or c-w telegraph transmission. If the transmitter is to be operated from a remote station on two-tone telegraph, c-w telegraph and telephone alternately, set the switch at TWO TONE, and make provision to set the two-tone telegraph circuit for the marking signal whenever the transmitter is used for telephone or c-w telegraph.

(3) The CONTROL switch is used to turn the transmitter off on channel 1 or channel 2, or to transfer these controls to the remote station where a similar switch may be used to perform these functions (fig. 30).

(4) The TEST KEY on the transmitter operates the carrier control relay when the transmitter is turned on by means of the local control. It is nonlocking in the down position, and locking in the up position. It is disconnected when the CONTROL switch is in the REMOTE position.

(5) The handset mounted on the audio amplifier panel may be used for telephone operation when the transmitter is turned on by means of the local control. A push button in the handle of the handset is used to operate the carrier control relay. When the CONTROL switch is in the REMOTE position this handset is inoperative.

h. D-c Power Supply Circuits. The rectifiers in the set furnish potentials from ground as follows: +30 volts for relays, —110 volts grid bias for tubes, and +700 and 1,600 volts for plate supply. The primary winding of the filament and 110-volt bias rectifier transformer is used as an autotransformer to deliver the proper voltages for operating the transmitter on any a-c line voltage between 200 and 250 volts. The proper transformer tap for any line voltage between these limits may be selected by a tap switch marked VOLTAGE, located on the front of the set, and is indicated by a 220-volt reading on the LINE VOLTS meter. A time delay feature is provided to obtain a warm-up period for the mercury-vapor rectifier tubes and to assure protective bias on the grids of the power amplifier tubes before high voltage is applied.

i. External Variable-frequency Oscillator. Provision has been made in the design of these transmitters to permit the use of an external variable radio-frequency oscillator for excitation instead of the crystal-controlled oscillator. A coaxial cable (N1) and plug (P1) are required for connecting the external

a. Assembly of Panels in Cabinet.

Quantity	*Unit*	*Over-all dimensions (in.)*		
		Width	*Height*	*Depth*
1	Cabinet	22¾	69¾	18½
1	Meter panel	19	7	2½
1	R-f power amplifier panel	19	8¾	16
1	R-f driver panel	19	8¾	16
†1	Audio panel	19	12¼	11
*1	Voltage divider panel	19	12¼	11
1	Power panel	19	14	15
1	Blank panel	19	10½	3/32

*Items not required with Radio Transmitter 33A. †Items not required with Radio Transmitter 34A.

b. Component Parts Shipped Separately, Permanently Assembled in Installation.

Quantity	Part	Over-all dimensions (in.)			Ref No.
		Width	Height	Depth	
†1	Transformer	7⅝	7⅝	5 11/16	T3
1	Transformer	7⅝	7¾	6⅝	T7
1	Transformer	9	9 11/16	8⅞	T8
1	Retard coil	7⅝	8½	5⅝	L32
1	Ventilating fan assembly, including:				
	1—Air filter, "dustop"	15	20	2	A1
	1—Fan motor, 230-volt, 50- to 60-c, with 12-inch 3-paddle bucket-blade.	16¼	21¼	6¼	B1

†Items not required with Radio Transmitter 34A.

c. Plug-in Parts Shipped Separately.

Quantity	Part	Ref No.
2	Plug fuse, 15-amp	F1, F2
1	Plug fuse, 1-amp	F3
1	Plug fuse, 2-amp	F4
2	Plug fuse, 10-amp	F5, F6
2	Keying relay	K1, K2
1	Vacuum Tube JAN-6J5 (VT-94)	V1
1	Vacuum Tube JAN-802	V2
2	Vacuum Tube JAN-807 (VT-100A)	V3, V26
1	Vacuum Tube JAN-OA3/VR-75 (VT-260)	V4
1	Vacuum Tube JAN-6H6 (VT-90)	V5
†1	Vacuum Tube JAN-6H6 (VT-90)	V21
2	Vacuum Tube JAN-813 (VT-144)	V11, V12
†2	Vacuum Tube JAN-6L7 (VT-87)	V16, V17
†1	Vacuum Tube JAN-6J8-G (VT-163)	V18
†2	Vacuum Tube JAN-828	V19, V20
1	Vacuum Tube JAN-5U4-G (VT-244)	V27
2	Vacuum Tube JAN-249B	V28, V29
2	Vacuum Tube JAN-866A/866 (VT-46A)	V30, V31
*2	Crystals	Y1, Y2
**2	R-f power amplifier tuning coils	L17, L18
†1	Handset	HS1
1	Plug	P1
‡ 50 ft	Shielded cable	N1

†Items not required with Radio Transmitter 34A.

‡Not shipped with the transmitter but may be obtained from depot stock.

* Orders for crystals should include the following information:

1. A statement that the crystal is for use in Radio Transmitter 33A or 34A.

2. Operating carrier frequency of transmitter.

3. Designated frequency of crystal.

4. To permit the ready identification of crystals where a number of different crystal frequencies are used or to facilitate selection from stock, nameplate colors are available. The order should include a statement of the nameplate color desired. These colors are:

Light red	Dark red	Yellow
Light green	Dark green	White
Light blue	Dark blue	Battleship gray
Light brown	Dark brown	Black

5. When Crystal Holder FT-249 is used, install the crystal in compartment A.

** Two r-f power amplifier tuning coils are required from the following list, depending on the frequencies used.

Carrier frequency	No. of turns
3.0 to 6.0 mc	9
4.5 to 9.0 mc	5
9.0 to 13.0 mc	4

radio-frequency source to the transmitter. Terminate cable N1 with plug P1 as shown in figure 47. External connection is made through a coaxial jack on the front of the transmitter. The external oscillator (not provided as a part of this transmitting equipment) must have a low impedance output to match the impedance of the 72-ohm coaxial cable and provide a voltage output between 35 and 50 volts root mean square (rms) at any frequency between 2.25 and 4.50 mc. Provide means for adjusting the output level of the external oscillator for best results.

2. MAJOR COMPONENTS AND PLUG-IN PARTS.

Equipment lists for each transmitter are given here. Reference numbers shown in these lists are the same as those used in drawings and illustrations. Some of the heavier power components used in these transmitters are shipped in separate packing cases and must be installed in the field. Vacuum tubes, polar relays, tuning coils, listed as plug-in parts, are also shipped separately. Items are also indexed in paragraphs 46 to 52, Maintenance Parts List.

d. Weights, Dimensions and Volumes of Equipment Packed for Shipment.

Equipment	*Over-all dimensions (in.)*			*Weight (lb)*	*Approx val. (cu. ft)*
	Height	*Width*	*Depth*		
Radio Transmitter 33A:					
Main transmitter	76	27	25	550	28½
Fan and housing	27	21	14	64	4½
Transformers	18	12	19	192	2¼
Vacuum tubes	26	20	26	85	8
Relays K1 and K2*					
Power amplifier plate coils					
Radio Transmitter 34A:					
Main transmitter	76	27	25	515	28½
Fan and housing	27	21	14	64	4½
Transformers	15	12	21	166	2 1/3
Vacuum tubes	26	20	26	64	8
Relays K1 and K2*					
Power amplifier plate coils					

*Relays packed in vacuum tube box.

SECTION II
INSTALLATION AND OPERATION

3. INSTALLATION.

a. Location of Transmitter. (1) This equipment is designed for fixed ground station applications and is suitable for indoor use where reasonable protection is provided against extreme weather conditions. A good location is one in which the equipment will have adequate protection against moisture, have ample space for ventilation, and be free from dust and dirt. In places where dust conditions are not severe, the spun glass air filter provided in the rear door of the transmitter will clean the air adequately. In cases where unusual amounts of dust are present, it may be necessary to clean or replace the air filters more frequently. The location should be such that the transmitter will not be subject to abnormal vibration.

(2) Outline dimensions for Radio Transmitter 33A and 34A and a view showing the conduit entrance in the bottom of the cabinet, are illustrated in figure 27. Allow at least 4 feet between the rear of the transmitter and the nearest obstruction for opening the door, installing the power apparatus, and inserting plug-in parts during installation and maintenance. This clearance is important also from the standpoint of ventilation, since cooling of the transmitter depends upon the flow of air throughout all parts of the interior of the transmitter cabinet.

b. Requirements for Power Supply. Power is derived from a 200- to 250-volt, single-phase 50- to 60-cycle source. Although the power required for operation of Radio Transmitter 34A is somewhat less than that of the Radio Transmitter 33A, because of the possibility of conversion from one type to another, it is advisable to provide a power supply source capable of handling a 2-kva (kilovolt-ampere) load in the installation of either type. The power supply source should have good regulation, particularly if the transmitter is operated from a remote control point, since the voltage tap switch can be used locally only. A constant line voltage is essential to the satisfactory operation of the transmitter. If loads other than that of the transmitter are fed from the same primary source, make adequate provision to avoid short time fluctuations. The leads between the primary source and the transmitter should be as short as possible to reduce the voltage drop to a minimum. Preferably, they should be brought into the transmitter through the conduit area in the bottom of the cabinet as indicated in figure 27. "Knockout" holes, 1⅛ inches in diameter, are provided in the sides of the cabinet and may be used as the entrance for the power supply leads or for connections to remote control equipment. All external connections to the transmitter with the exception of those to the antenna system are made to terminal strip TS1.

c. Connections for Remote Control. (1) Refer to typical circuit diagram for the remote control equipment (fig. 30), and schematic diagram of Radio Transmitter 33A (fig. 28). Operation of the POWER switch on the front of the set to the ON position and the CONTROL switch to the REMOTE position, places the transmitter under control of the remote station. The leads used for controlling the operation of relays in the transmitter from the remote point require a ground return, or preferably a separate ground lead, between the transmitter and remote point. The lead designated CHAN. #1—MAST. CONTROL on terminal strip TS1 (fig. 3), is used to control power relay K16 in the transmitter. This relay closes the line circuit to the principal power components. The lead designated CHAN. #2 is used to control the channel switching re-

lays in the transmitter. The CW #1 lead is used to operate the carrier control relay in the transmitter and provides the keying circuit for c-w telegraph transmission. The leads marked T and R—SPEECH LINE comprise a balanced 500- to 600-ohm telephone line. With the CONTROL switch in the REMOTE position, these two leads are terminated at the input transformer of the audio amplifier. Another pair (balanced circuit) is used between the transmitter and the two-tone telegraph equipment. This line is terminated in a winding of two-tone telegraph relay K1. The lead marked CW #2 is provided for the same purpose at the outlying telegraph equipment location as the CW #1 lead at the remote control station; that is, to operate the carrier control relay in the transmitter or for c-w telegraph transmission.

(2) Remote control of the transmitter may be effected over wire loops (control lead and ground return) up to the values below:

Circuit	*Maximum loop resistance (ohms)*
CHAN. #1—MAST. CONTROL	100
CHAN. #2	100
CW #1	1,000
CW #2	1,000

Variable resistors R2, R3, R5, and R6 are provided in the transmitter to compensate for operating loop resistances less than those shown above.

(3) Loop resistance values are based on unfavorable conditions, such as minimum a-c line voltage for operating the transmitter, and commercial variations in relays. Under more favorable conditions the operating loop range may be extended somewhat beyond these values. However, if it is necessary to extend the operating range for the circuits of the main power and channel switching relays appreciably beyond these values, it is possible to provide separate batteries in series with each line at the remote station, and thus increase the operating current of the relays. The loop resistance may be extended to several thousand ohms by using sensitive relays connected so that their contacts close CHAN. #1 MAST. CONTROL and CHAN. #2 terminals to GRD terminal, respectively. The coils may be actuated from the + 30V DC terminal, through suitable current limiting resistors, and controlled through the loop.

(4) If the radio transmitter and the remote control equipment are located in the immediate vicinity of power distribution lines or electric railways, ground potentials may be of sufficient magnitude to affect relay operation. This condition can be remedied by the use of a separate conductor to provide the ground return between the transmitter and remote control equipment.

(5) The permissible loss in the speech line will depend upon the voice level at the microphone, but the line loss shall not be so great as to result in a speech input level at the transmitter of less than —35 db (0.006-w reference level).

(6) The permissible loop resistance of the two-tone telegraph keying circuit is dependent on the battery supply voltage provided by the two-tone telegraph equipment. Normal operating current for this circuit should be approximately 20 milliamperes.

(7) Control of Radio Transmitter 34A from the two-tone telegraph equipment is the same as described for Radio Transmitter 33A. However, no telephone facilities are available as a part of this transmitter.

d. Antenna Systems. These transmitters are designed primarily to work into a balanced antenna system, such as a doublet or rhombic, having a 600-ohm impedance. The type of antenna used depends upon the carrier frequency and the purpose for which the transmitter is to be used. Each transmitter normally is connected to two different antennas which are adjusted individually to obtain maximum efficiency at the particular frequency used. It is possible, however, that any of the following types of antennas may meet the particular needs of the service.

Frequency (mc)	*Type of antenna (fig. 31)*
3–6	Vertical quarter-wave
3–13	Horizontal doublet
6–13	Rhombic
6–13	Inverted V
3–13	Arrays for special use
3–13	Doublet with director and reflector

(1) The transmitter cabinet should be thoroughly bonded to nearby metal structures such as building frame, metal roofs, water or gas pipes, conduit, or heating systems. When an unbalanced or grounded antenna system is used for either channel, one of the output terminals for that channel should be connected to the antenna ground system and to the transmitter cabinet by means of a low impedance conductor run as directly as possible.
(2) When the transmitter works into a transmission line, it may be desirable to make preliminary tuning adjustments with an artificial antenna. The artificial antenna may consist of one or more noninductive resistors in series with variable capacitors and an r-f ammeter. Since the output circuit of the transmitter is symmetrical, a balanced type of artificial antenna connected to the terminal posts on the top of the transmitter unit (fig. 31) is recommended. The resistors may be used in a series parallel combination as required to approximate the characteristic impedance of the line.

e. Installation of Ventilating Fan, Power Transformers, and Choke Coil. Be careful in unpacking or handling the equipment, particularly the separately crated component parts. Inspect all the high-voltage insulators and bushings on the transmitter unit and power transformers to make sure that none has been broken during shipment.
(1) Install the ventilating fan assembly in the cabinet door after the transmitter is set up in its final location. This assembly is mounted in place by 10 screws, two of which have nuts and washers. A cable clamp is included among the parts furnished with this assembly. It is required to secure the motor leads in place to prevent their becoming pinched between the edge of the door and cabinet. Mount the cable clamp under a screw provided for mounting the fan assembly, using the one in the second position up from the bottom on the hinged side of the door. The ventilating fan assembly as it appears from the inside of the door is shown in figure 4.

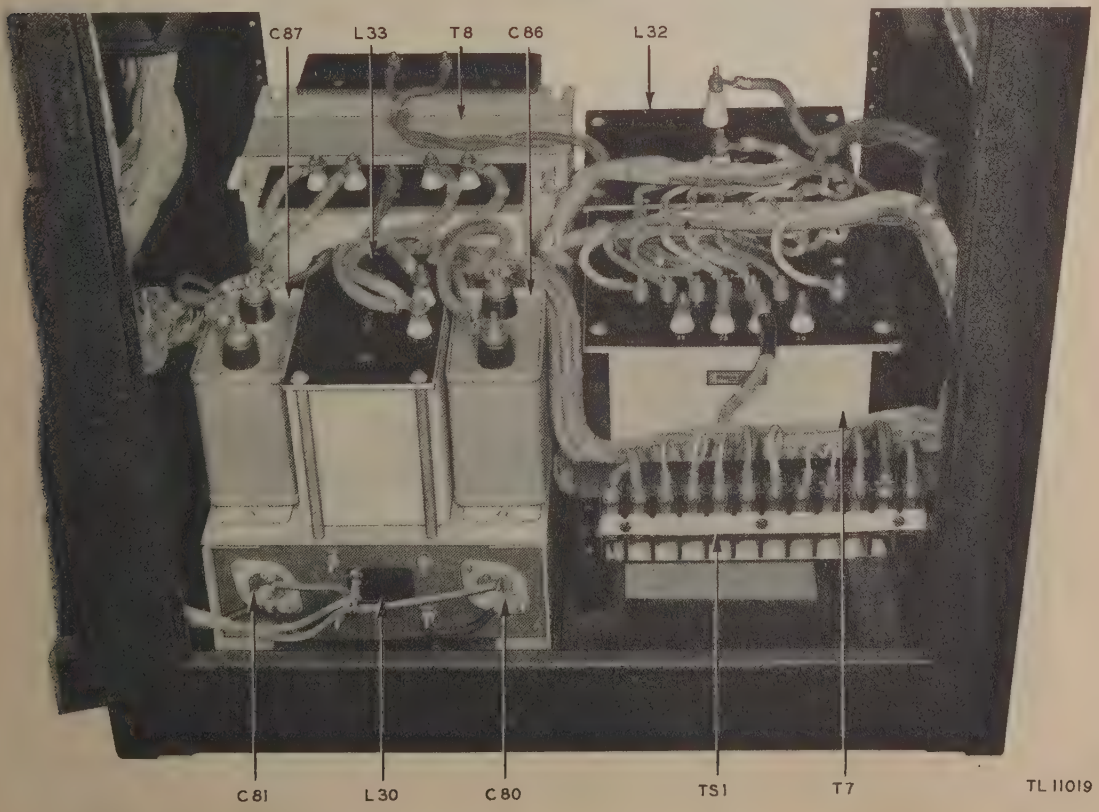


Figure 3. Cabinet, interior view of bottom.

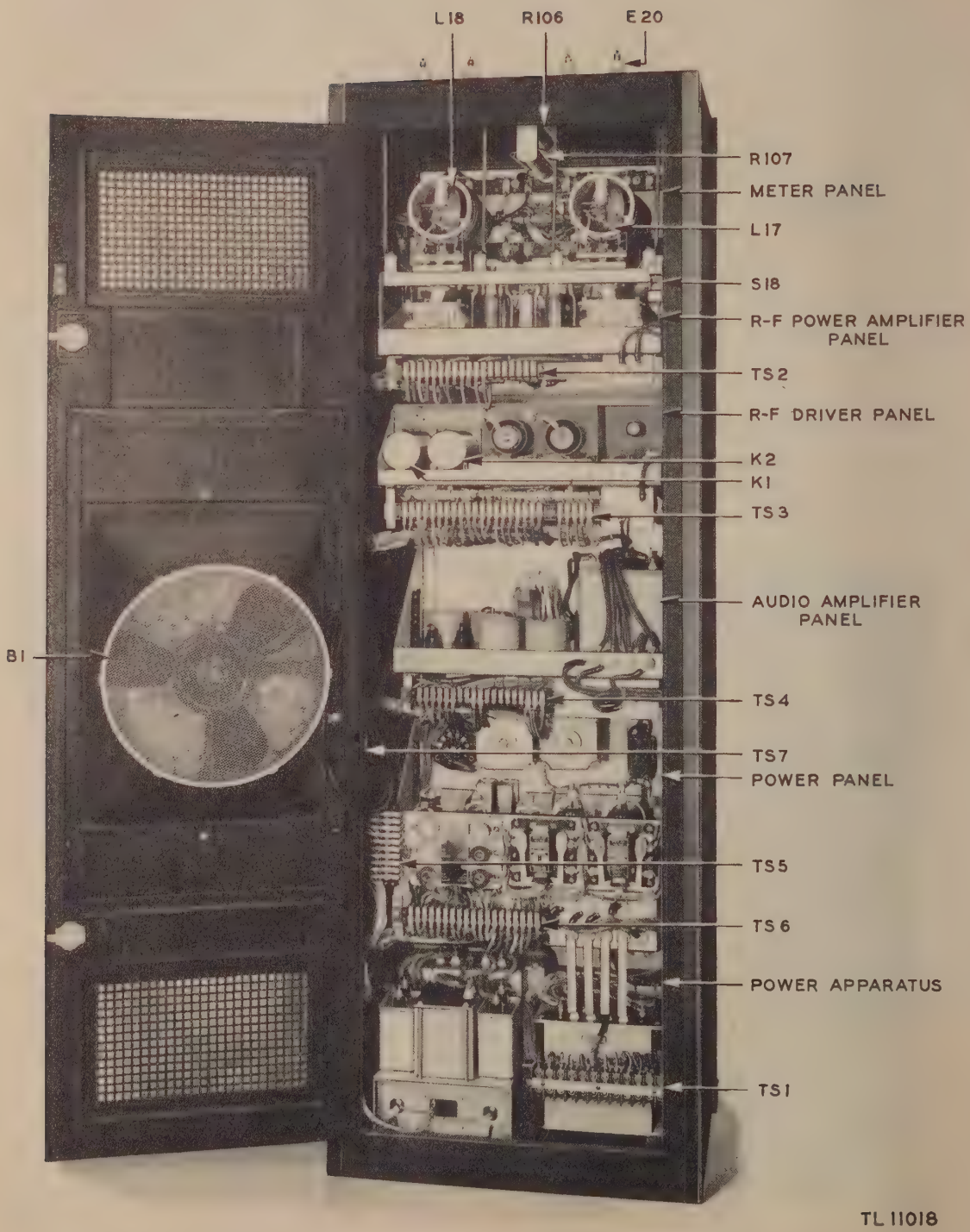


Figure 4. Radio Transmitter 33A, interior view from rear.

(2) The arrangement of the power apparatus in the bottom of the cabinet and the manner in which the leads are brought out of the cables and wired, are shown in figure 3. Outline drawing (fig. 27) also indicates the location of these power components. To install the power transformers and choke coil temporarily remove the audio amplifier and power unit from the cabinet. Disconnect the wiring from the rear terminal strips and remove the screws from the front panels of the audio amplifier and power unit. Remove the bolts which clamp the chassis to the mounting brackets on the inside of the cabinet. Remove each chassis carefully so as not to damage any apparatus. Also remove the blank panel in front of the power apparatus in the bottom of the cabinet.

(3) Mount transformers T7 and T8 and choke coil L32 in the position shown by the installation drawing (fig. 27) and secure them in place by means of the four screws furnished for each unit. Make all connections between transformers T7, T8, and choke L32 to the conductors in the main cables as shown in the transmitter wiring diagram (fig. 32). The cable ends are equipped with metal tags marked to correspond to the terminal numbers on the transformers and choke to which they connect.

CAUTION: Be sure that no wire makes contact with another terminal or with any other part of the set and that all of the terminals are locked firmly in place.

(4) Return the blank panel and the power panel to their proper positions and replace the screws which secure these panels to the front of the cabinet. Assemble the four copper strip connectors between terminals 20, 21, 22, and 23 on transformer T7 and terminals 37, 36, 35, and 34 respectively, directly above on the power panel. Make the connections between the terminal strip of the power panel and the main cable. Be sure that the color of the wire connected to each terminal corresponds to the color code shown in figure 32.

(5) To install transformer T3 on the audio amplifier panel, place the transformer on the chassis in its proper location, tilt it back to a convenient angle and insert screws in the two holes nearest the front panel. Then lower the transformer until the screws just engage with the threaded holes in the chassis. Insert a long-bladed screwdriver through the holes in the terminal plate and tighten the screws. Install the two screws which hold the rear of the transformer in place on the chassis. Wire transformer T3 as shown on transmitter wiring diagram (fig. 32). Return the audio amplifier unit to the cabinet and replace the screws removed from the front panel. Finally, make all connections between its terminal strip and conductors in the main cable by reference to figure 32.

(6) Reinstall bolts clamping the mounting brackets on the inside of the cabinet to the channels on the rear of the chassis. The transmitter cannot be safely reshipped from its original location to any other point, without disassembling the heavier power components from the cabinet and replacing these screws.

f. Preparation for Use. Manufacturers' type numbers for vacuum tubes are marked on the chassis near the sockets throughout the set. Circuit reference numbers are marked on fuse mountings F1 to F6 inclusive, line compensating resistors R2, R3, R5, and R6, and jacks J1 and J2, so that these items may be readily identified to facilitate installation and adjustment. Jacks J1 and J2 serve as mountings for polar relays K1 and K2.

(1) To insure against the accidental presence of high voltage, do not place fuses F5 and F6 in their sockets until low-voltage tests have been completed and the results are satisfactory. Install all other fuses, vacuum tubes, telegraph relays, and handset, if used, in their respective sockets or mountings as indicated below.

(2) Install two r-f power amplifier plug-in coil units in their respective sockets on the rear of the power amplifier chassis. The coil units used depend on the operating carrier

Part	*Ref No.*	*Description*
Fuses.....	F1, F2	15-amp, plug.
	F3	1-amp, plug.
	F4	2-amp, plug.
Polar relays....	K1, K2	136-ohm, 0.005-amp 150-volt, SPDT.

Part	*Ref No.*	*JAN-type*	*Signal Corps type*
Vacuum tubes...	V1	6J5	VT-94
	V2	802	
	V3, V26	807	VT-100A
	V4	OA3/VR-75	VT-260
	V5	6H6	VT-90
	V11, V12	813	VT-144
	†V16, V17	6L7	VT-87
	†V18	6C8-G	VT-163
	†V19, V20	823	
	†V21	6H6	VT-90
	V27	5U4-G	VT-244
	V28, V29	249B	
	V30, V31	866A	VT-46A
Handset	†HS1		

†Indicates items not used with Radio Transmitter 34A.

frequencies of the transmitter. They may be identified by the number of turns as follows:

For 3.0-6.0 mc, 9 turns
For 4.5-9.0 mc, 5 turns
For 9.0-13.0 mc, 4 turns

(3) After all plug-in parts have been placed in their respective sockets, with the exception of fuses F5 and F6, and before the power supply is connected to the transmitter, set the control switches located on the front of the transmitter to the positions indicated below.

Circuit reference	*Switch or control designation*	*Starting position*
S1	EMISSION	PHONE CW
S2	CONTROL	OFF
S4	TEST KEY	* (Unoperated)
S11	DC METER SWITCH	1600 V. RECT
S16	POWER	OFF
S17	VOLTAGE	1

*TEST KEY, S4, is in the unoperated position when its handle is perpendicular to the front panel.

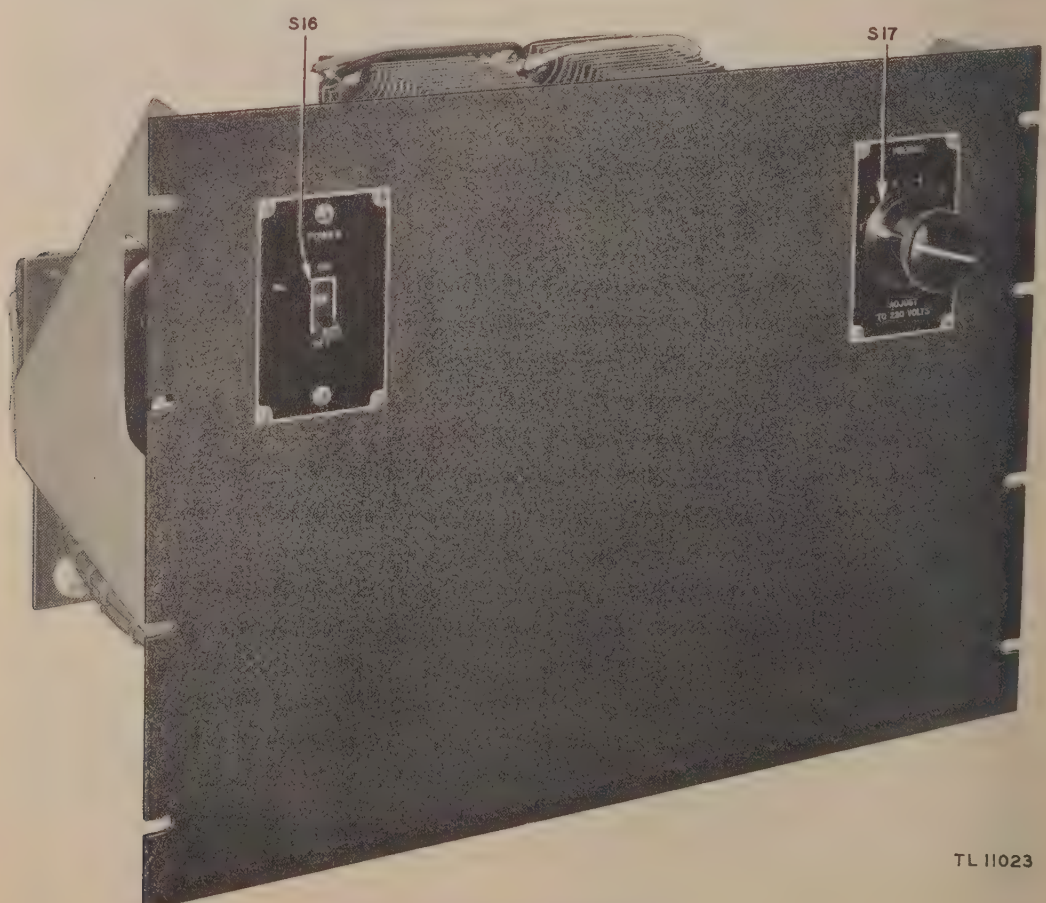


Figure 5. Power panel, front view.

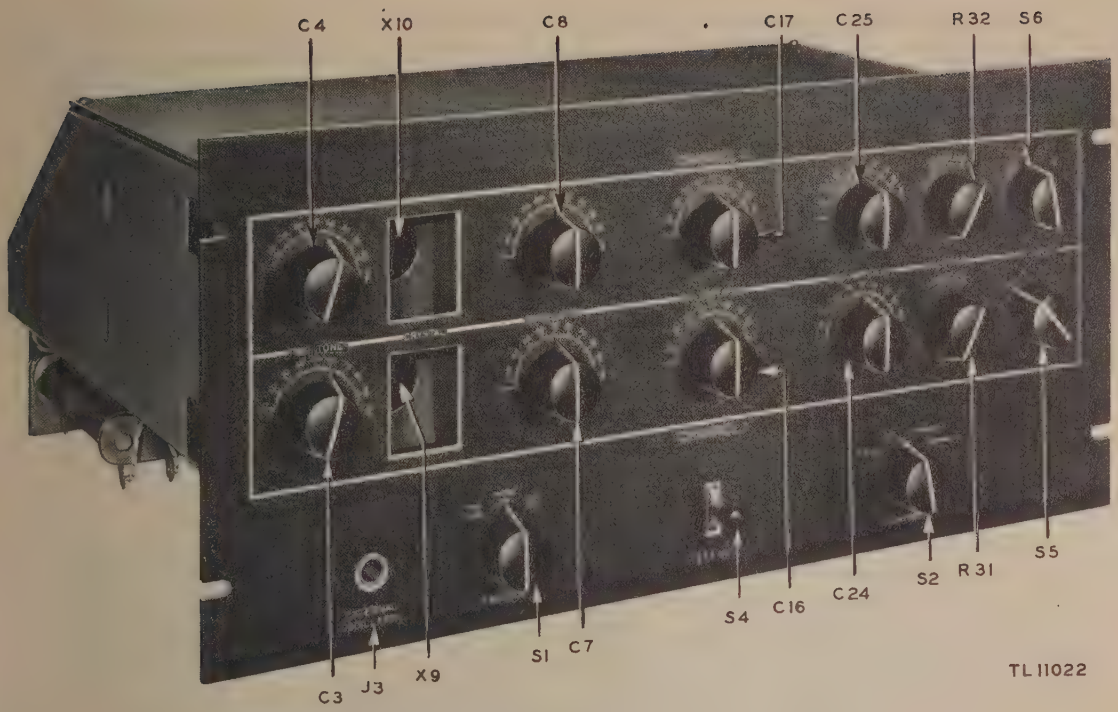


Figure 6. R-f driver panel, front view.

4. OPERATION.

a. Initial Procedure. Check the transmitter to make sure that the instructions up to this point have been carefully followed, and that the antenna (or suitable artificial antenna) and ground connections have been properly made. Connect the transmitter to the power supply and associated control circuits as shown on the schematic diagram (fig. 28 or 29) and transmitter wiring diagram (fig. 32).

CAUTION: Check that fuses of the proper ratings are in sockets marked F1 to F4, inclusive. Make sure that no fuses are in sockets marked F5 and F6. Dangerously high voltages are present when the transmitter is in operation. Safety features of the set should be understood thoroughly before attempting to make any adjustments. It is particularly important that the functions of the safety switch in the cabinet door, time delay Tube VT-100A (V26), power line relays K16 and K18, and of each of the fuses used in the equipment are understood thoroughly.

In the initial testing of the transmitter, make the following observations of the operation of the low-voltage power supply and control circuits.

(1) Set POWER switch S16 (fig. 5) to the ON position. This immediately energizes transformer T6 and its associated copper oxide rectifier, COR1 and COR2, and provides current for operating relays.

(2) Set CONTROL switch S2 (fig. 6) to the CHANNEL 1 position. Observe that the indicator lamp on the front of the r-f power amplifier panel lights. This serves as an indication that the filament and low-voltage rectifier transformer T7 is energized through the contacts of VOLTAGE switch S17.

(3) Advance the setting of the VOLTAGE switch from position 1 to the tap setting which gives a voltage reading on LINE VOLTS meter M1 as close as possible to 220.

CAUTION: Never start the transmitter after changing the primary voltage which might result in the application of more than 220 volts a-c to the transmitter, without first setting the VOLTAGE switch to position 1. After power is turned on, advance the setting of this switch step-by-step until a voltage reading of 220 is obtained.

(4) Check that from a start with all tubes cold, the time delay tube requires approximately 20 seconds to operate relay K17.

(5) Observe that the filaments and heaters of all glass tubes throughout the set are lighted. Voltage regulator Tube VT-260 (V4) has no filament.

(6) With CONTROL switch S2 in the CHANNEL 1 position, observe that relay K9 in the back of the r-f driver panel is operated.

(7) Set CONTROL switch S2 to the CHANNEL 2 position and observe that relays K7 and K8 operate, that K9 releases, and that K11 in the r-f power amplifier operates. Other relays in the transmitter also operate with the change in position of the CONTROL switch, but they cannot be observed as they are located behind shields in the r-f driver unit. Relays K8 and K9 are fast operate — slow release relays disconnecting the plate circuit to the first r-f amplifier whenever they are both operated. These two relays are timed so that both are operated for a short interval when the CONTROL switch is changed from one channel position to the other. During this time delay, relay K11 in the r-f power amplifier panel is given time either to operate or release to switch from one channel to the other with no r-f voltage across its contacts.

(8) Change the setting of CONTROL switch S2 from CHANNEL 2 to CHANNEL 1 and observe that relays K7, K8, and K11 release and that K9 operates.

(9) Restore the CONTROL switch to the OFF position and observe that relay K9 releases and that the indicator lamp goes out.

(10) Should any of these observations indicate unsatisfactory performance, locate the fault and correct it before proceeding. A check of the power supply voltages given in paragraph 43 should indicate the source of the difficulty.

b. Initial Tests of High-voltage Rectifiers.

CAUTION: No tests involving the use of 1,600-volt plate power should be made unless both power amplifier plate tuning coil assemblies L17 and L18 are in place in sockets J6 and J7 of the power amplifier for channels 1 and 2, respectively. Plate power to the 813 tubes is supplied through the windings of these coils. If the 1,600-volt plate circuit is open to the power amplifier tubes and r-f drive is applied to the control grids, filament emission may burn out the screen grids of the tubes.

(1) Set POWER switch S16 to the ON position and CONTROL switch S2 to the CHANNEL 1 position. Permit the set to operate for a period of not less than 30 minutes, observing that the indicator lamp on the front of the r-f power amplifier panel is lighted during this time. This heating period is required to condition 249B and 866A mercury-vapor rectifier Tube (VT-46A) before plate voltage is applied.

CAUTION: A filament heating period of 30 minutes or more must be allowed when either 249B or 866A mercury-vapor Tubes VT-46A are used for the first time, or if they have been subjected to handling or prolonged standing.

(2) After the filaments of the mercury-vapor tubes have been lighted for the required heating period, operate the POWER and CONTROL switches to their OFF positions.

(3) Install fuse F6 on the power panel, thereby closing one side of the line circuit to transformer T8. Operate the POWER switch to the ON position and the CONTROL switch to CHANNEL 1. Closing and opening the door should start and stop the fan motor.

(4) Operate the POWER and CONTROL switches to their OFF positions. Install fuse F5 in the proper position on the power panel. Close the door and operate the POWER switch to the ON position and the CONTROL switch to CHANNEL 1. After the time delay necessary for the operation of relay K17, the anode voltage will be closed to both the 700- and 1,600-volt rectifier tubes. With the DC METER SWITCH in the 1,600 V. RECT. position, observe that the voltage is approximately 1,600 volts. Set the DC METER SWITCH in the 700 V. RECT. position and observe that the reading is approximately 700 volts. Turn the POWER and CONTROL switches to their OFF positions.

c. Tuning Procedure. If all instructions up to this point have been followed carefully, it should be possible to tune the transmitter at its operating frequencies. Since the tuned r-f

circuits of the two channels are identical, channel 1 is used in the following description of the tuning adjustments of the transmitter. A tuning chart is provided on the front of the r-f power amplifier panel to serve as a guide in making the initial adjustments. This tuning chart is also shown as paragraph 40.

CAUTION: Excessive plate current in the 813 tubes results in short tube life and may seriously damage the tubes within a few minutes. In tuning the set be careful to avoid this condition by frequent checking of the r-f power amplifier space current. It should not exceed 355 milliamperes. The plates of these tubes should show no color when operating properly in this transmitter.

In tuning the transmitter, the various steps should be followed in the sequence below.

(1) Adjust the antenna coupling coil inside the power amplifier plate tuning coil to minimum coupling, that is, with the antenna coil axis perpendicular to the plate tuning coil axis.

(2) Set the tuning adjustments approximately for the operating frequencies as shown on Tuning Chart, paragraph 40.

(3) Set the 2ND AMPLIFIER tuning adjustment as far off as possible to protect the r-f power amplifier during the initial procedure.

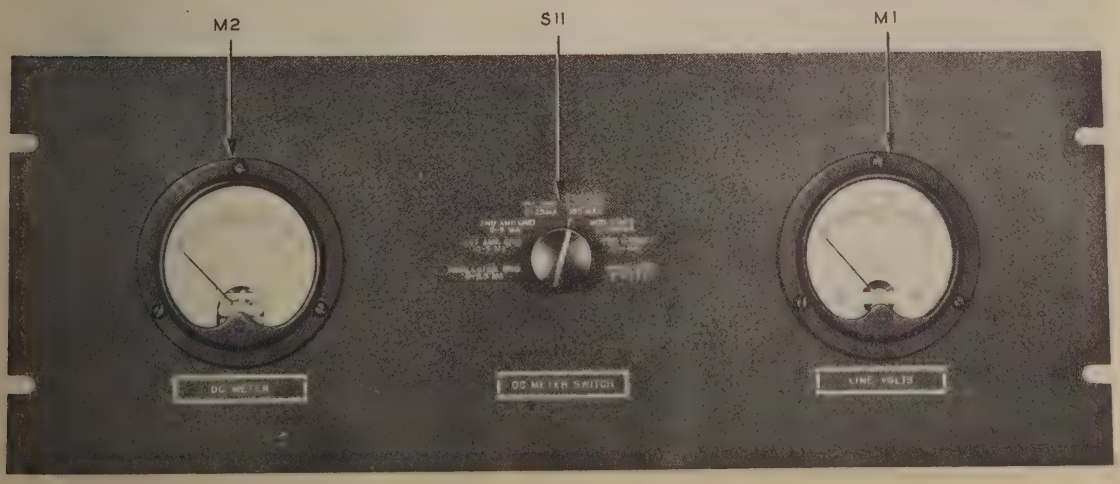
(4) Set the DC METER SWITCH (fig. 7) to OSCILLATOR GRID. Operate TEST KEY S4 and adjust the OSCILLATOR dial of CHANNEL 1 to obtain the maximum oscillator grid current reading. Increase the OSCILLATOR dial slightly (in the direction of a higher dial reading) past the peak setting to a point where the grid current is 90 percent of the maximum grid current reading.

(5) Set the DC METER SWITCH to P.A. SPACE and observe whether there is an indication of space current in the r-f power amplifier (pa) stage. If any space current is indicated adjust P.A. TUNING 1 (fig. 8) to the setting which gives *minimum* power amplifier *space current.*

(6) Set the DC METER SWITCH to 1ST AMP. GRID and observe that grid current is indicated. This grid current is the result of the setting of the OSCILLATOR tuning dial in the position indicated in subparagraph (4) and no further change in the setting of the OSCILLATOR dial should be made.

(7) Set the DC METER SWITCH to 2ND AMP. and adjust the 1ST AMPLIFIER dial for a peak grid current reading. EXCITATION control for CHANNEL 1 may be used, if necessary, to increase the second amplifier grid current to approximately 1 milliampere.

(8) Set the DC METER SWITCH to P.A. SPACE and adjust the 2ND AMPLIFIER tuning to obtain a small increase in the power amplifier space current. With this setting adjust P.A. TUNING 1 for *minimum* power amplifier *space current.*



TL11020

Figure 7. Meter panel, front view.

(9) Set the DC METER SWITCH to P.A. GRID and adjust 2ND AMPLIFIER tuning to a peak grid current reading.

(10) Again set the DC METER SWITCH to P.A. SPACE to be sure that P.A. TUNING 1 is in such a position that it gives the exact *minimum* of the power amplifier *space current.*

(11) Increase the antenna coupling in small steps until the power amplifier space current is increased with the P.A. TUNING 1 in the tuned position.

(12) If an artificial antenna is used, adjust its variable capacitors until maximum antenna current is obtained. The capacitance in the two sides of a balanced artificial antenna should be substantially equal when properly adjusted. Increase the antenna coupling in small increments until the power amplifier space current is 345 ± 10 milliamperes. Recheck the setting of the OSCILLATOR dial for 90 percent of the *new maximum* oscillator grid current as outlined in subparagraph (4) and then check the setting of 1ST AMPLIFIER and 2ND AMPLIFIER dials for *maximum* grid currents of the second amplifier and power amplifier stages respectively. Recheck P.A. TUNING 1 for *minimum* power amplifier space current of 345 ± 10 milliamperes. Optimum performance of the transmitter is obtained when the power amplifier grid current is 10 ± 2 milliamperes. There should be sufficient drive to the power amplifier tubes to obtain grid current readings between these limits, Increased drive, which may be found with some tubes, is not harmful except that it may result in a slight decrease of output power. This completes the tuning operation of the transmitter for c-w or telephone operation using an artificial antenna. The power output under this condition should be approximately 350 watts.

(13) When adjusting the transmitter to work into a real antenna, follow the same

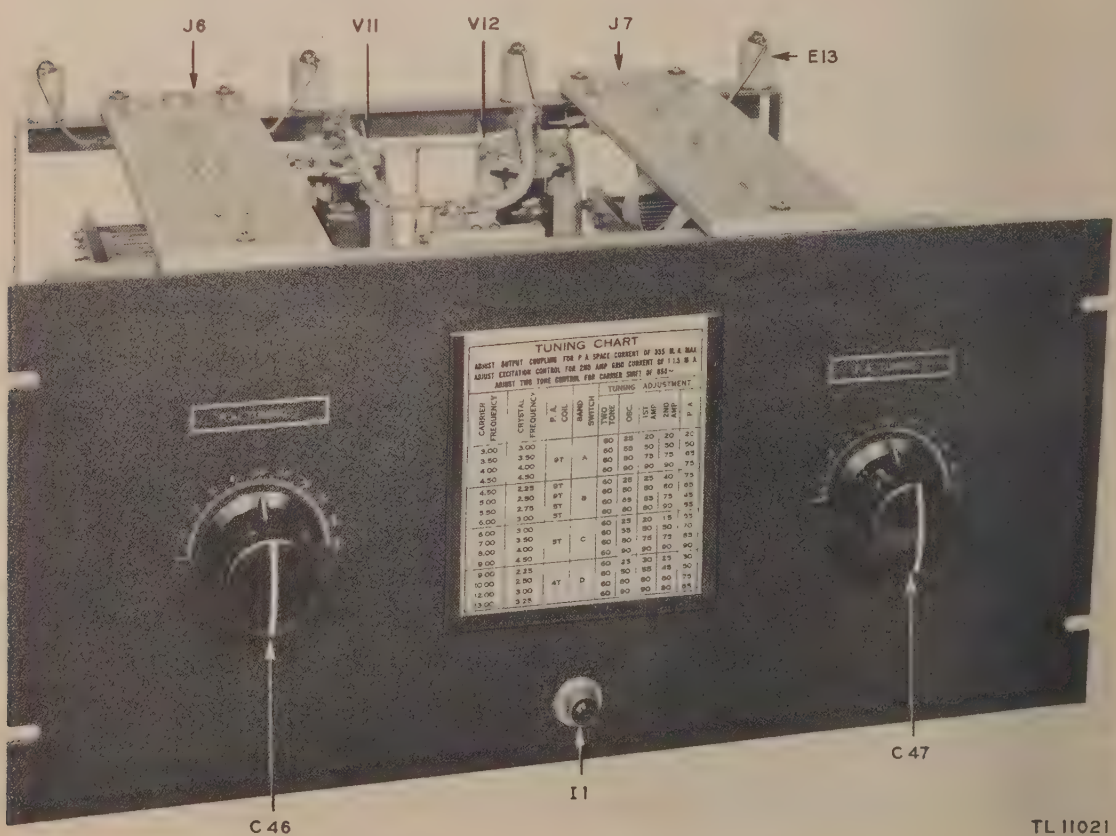


Figure 8. R-f power amplifier panel, front view.

procedure if tuning adjustments and ammeters are provided with the antenna. Adjust the antenna system to resonance at the operating frequency when the coupling coil in the transmitter is connected and adjusted to approximately minimum coupling. The coupling should then be increased in small steps until the power amplifier space current is 345 ± 10 ma with P.A. TUNING 1 adjusted for *minimum* space current. If the antenna is properly tuned, the final adjustment of P.A. TUNING 1 should be substantially the same as that obtained in subparagraph (10).

(14) Record the settings of all dials for future reference. Space is provided on the back of the tuning chart for this purpose.

(15) The above procedure for tuning the transmitter is the same for all frequencies in the entire range of the equipment. Typical meter readings for tuned circuit conditions for two frequencies in each band are shown in paragraph 42. These values must be considered approximations only.

(16) There are no differences in the r-f circuits of the two channels of these transmitters and they should therefore perform equally well on channel 1 or channel 2. The transmitter may be operated with any two plate tuning coil assemblies in channels 1 and 2 provided the appropriate coils and crystals are used for the particular *output* frequencies.

d. Modulation of Transmitter. After Radio Transmitter 33A has been tuned for c-w oper-

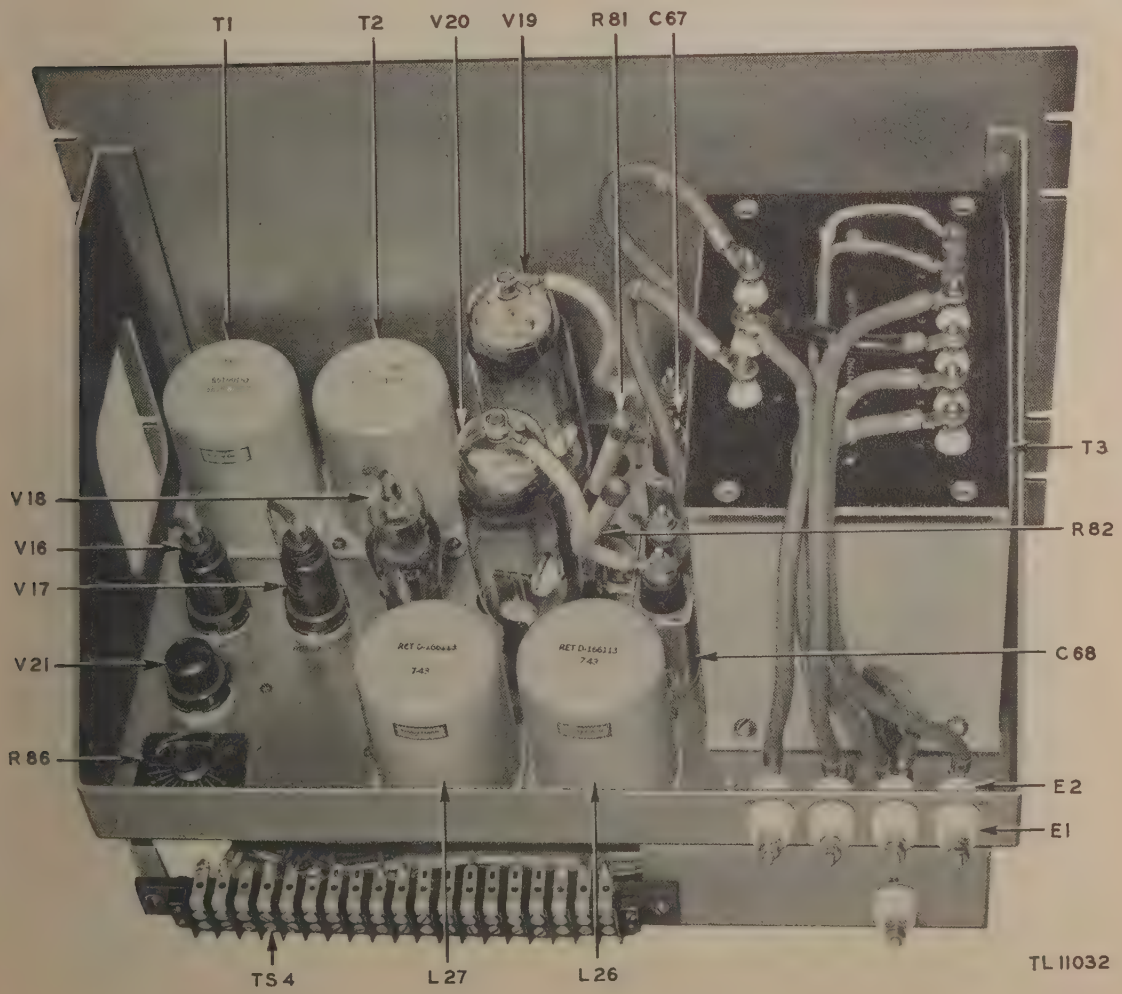


Figure 9. Audio amplifier panel, top view.

ation, restore the TEST KEY and modulate the transmitter by the handset microphone located on the front of the set. One of the contacts on the press-to-talk switch in the handset handle is in parallel with the contacts on the TEST KEY and performs the same function in the control of the carrier. Another contact on the press-to-talk switch furnishes current to the microphone from a voltage divider on the 110-volt bias rectifier. Set DC METER SWITCH S11 to its MOD. SPACE position. Speak into the microphone and observe that the modulator space current fluctuates from an initial reading of approximately 20 to 80 ma and reaches occasional values of 250 ma. This is a measure of the degree or percentage of modulation. The modulation level is automatically controlled by the volume limiter which continually adjusts the gain of the audio amplifier. However, there is an adjustment on the volume limiter which must be set properly when the transmitter is installed and may need to be readjusted when the associated tubes V16 and V17 (Tube VT-87), or V21 (Tube VT-90) are changed. This adjustment is potentiometer R86 located in the left rear section of the audio amplifier chassis, which is turned in a clockwise direction to increase the level of modulation (fig. 9). The r-f power amplifier space current should not change appreciably with modulation.

e. Adjustments for Two-tone Telegraph Operation. The carrier frequency shift in all bands during two-tone telegraph operation is 850 cycles. Since the multiplication of the crystal frequency varies with different bands, this is accomplished by a change in the frequency of oscillation of 850 cycles in band A, a change of 425 cycles in bands B and C, and a change of 212½ cycles in band D. The crystals supplied require individual adjustments of the variable air capacitor, marked TWO TONE, to obtain the change in frequency of oscillation. In making these adjustments for two-tone telegraph operation, it will be necessary to establish communication with the two-tone telegraph station in order that marking or spacing signals may be sent to the radio transmitter as required. It is assumed that the radio transmitter has been tuned properly under local control and as the tuning of the various stages for two-tone operation is the same as outlined above for c-w or telephone operation, this information will be confined to two-tone operation. Take a record of meter readings at this time. Steps required for initial adjustments are as follows:

(1) Refer to paragraph 41 and set the TWO TONE dial of the channel to the approximate point indicated for the crystal frequency and carrier frequency being used.

(2) Set CONTROL switch S2 to REMOTE and request the operator at the two-tone telegraph station to turn his set *on*. He closes a switch which connects ground to the CW #2 lead operating relay K2 to its *marking* contact (No. 4), thereby starting the oscillator and putting steady carrier on the antenna. This steady carrier remains *on* as long as the two-tone set is *on*. At the same time *negative* potential is sent over the T-lead of the two-tone line operating relay K1 to its *marking* contact (No. 4).

(3) Operate EMISSION switch S1 on the r-f driver panel to TWO TONE; note there is little or no change in the oscillator grid current reading. A change in this reading at this time usually indicates that the two-tone line is transposed. To check the line polarity, turn CONTROL switch S2 to OFF and *then* observe the position of K1 relay armature. If it is closed on the left-hand contact, looking at the armature end of the relay, transpose the two-tone line where it connects to the transmitter and then observe that the armature of relay K1 is closed on its right-hand contact which is the *marking* contact. Turn the CONTROL switch back to REMOTE and proceed.

(4) Request the two-tone telegraph operator to hold his *break* key in the operated position. This reverses the polarity of the potential sent to the transmitter over the two-tone line and operates relay K1 to its *spacing* contact (No. 5) and shifts the carrier frequency *downward*.

(5) Check the meter readings for all stages and compare with the readings noted for normal c-w or telephone operation. The oscillator and first amplifier grid current readings may be appreciably reduced and a slight reduction in the second amplifier grid current may be noted, but the p-a grid current, p-a space current, and antenna current (if a meter or indi-

cating device is used) should show *no change*.

(6) Request the two-tone telegraph operator to check with the receiving station and determine if the frequency shift is satisfactory. It may be necessary for him to operate and release his *break* key several times while making this check. If the frequency shift is *less* than the required 850 cycles, the setting of the TWO TONE dial of the channel in use should be changed to a lower point and the shift rechecked several times. If the frequency shift is *greater* than 850 cycles, set the TWO TONE dial to a higher point.

(7) After determining the setting of the TWO TONE dial for a carrier frequency shift of 850 cycles, recheck all meter readings as outlined under subparagraph (4) for both *marking signals* (*break* key normal), and *spacing* signals (*break* key operated). The p-a grid and p-a space currents should show *no change* under either condition. It may be necessary to advance the EXCITATION control slightly in a clockwise direction to obtain a steady p-a grid current.

(8) Inform the two-tone telegraph operator that the circuit is ready for use. Note that the p-a grid and p-a space currents do not vary when two-tone telegraph pulses are being sent over the line.

(9) Record the settings of all dials for future reference when the same crystal is to be used for two-tone telegraph on the same carrier frequency. Space is provided on the back of the tuning chart for this purpose.

f. Use of TWO TONE Control for Adjusting Crystal Frequency for C-w Telegraph or Telephone Operation. (1) The TWO TONE controls (C2 and C3) are primarily intended for use as a means of adjusting the frequency shift when two-tone telegraph is used. However, these controls may be used when c-w or *telephone* operation is utilized to permit a slight change in frequency in case of adjacent channel interference or to compensate for slight variations in crystal frequencies due to manufacturing tolerances.

(2) For c-w or telephone operation the EMISSION switch should normally be set to PHONE CW and the TWO TONE dials at 60. This provides a circuit condition equivalent to that used in the manufacture and calibra-

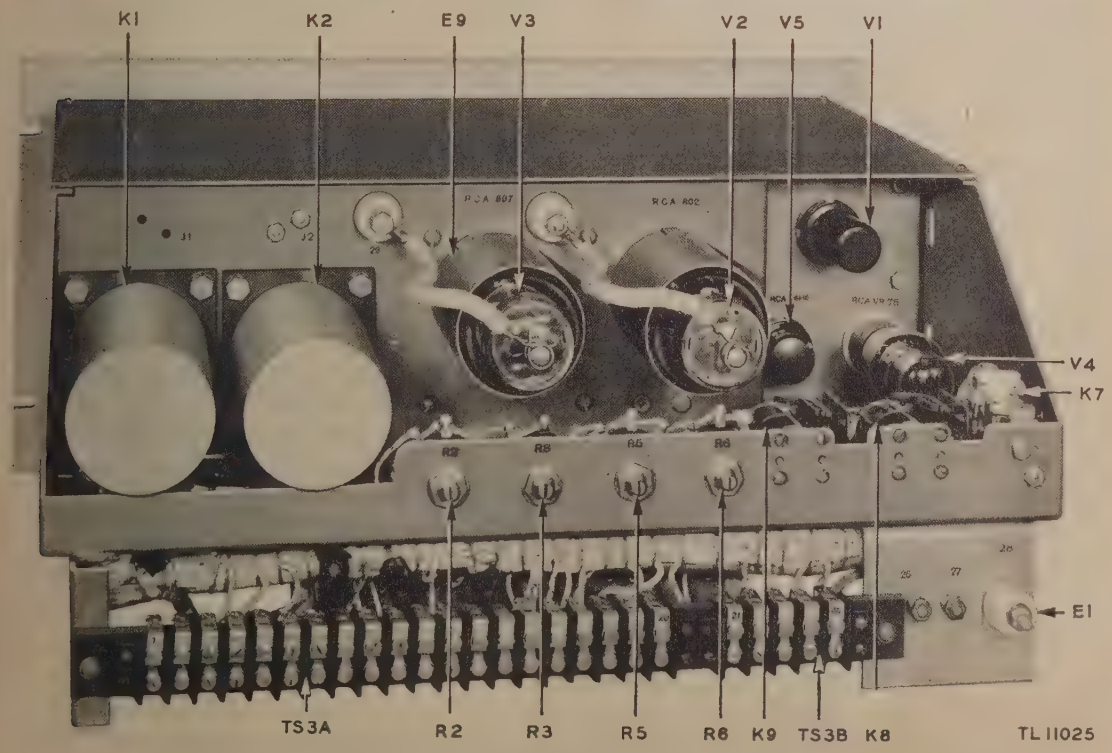


Figure 10. R-f driver panel, rear view.

tion of the crystals used in the transmitter. This should result in an oscillator frequency within ± 0.01 percent of the frequency stamped on the crystal holder nameplate.

(3) If it is desired to shift the carrier a few cycles to fit into net operation with other stations on the same frequency, the TWO TONE dial may be reset to any new point in its range. A frequency change of as much as approximately + 0.01 percent or — 0.005 percent may be obtained in this way. However, phone or c-w operation should not be attempted with any setting of the TWO TONE dials which reduces the oscillator grid current to a value of 25 percent below that obtained with the dial set at 60.

g. Adjustments for Remote Control Operation. (1) Line compensating resistors are connected in series with the lines used to control the transmitter from remote control positions, with the exception of the line circuit to the two-tone polar relay K1. These resistors are mounted on the rear of the r-f driver unit (fig. 10) in an accessible location where they are marked for identification. They are adjusted by inserting a milliammeter in series with each of the respective control leads, and varying the resistances until the proper operating current for each relay is obtained. The compensating resistors, the control leads in which they are used, and the relays for which these adjustments are required are shown below:

Resistor	*Control lead*	*Relay*
R2	CW #2	K2 —carrier control
R3	CW #1	K2 —carrier control
R5	CHAN. #1—MAST. CONTROL	K16—power supply
R6	CHAN. #2	K7 —channel selection

Before making adjustments of the line compensating resistors, make sure that all connections have been completed between the transmitter and remote control station as shown in figure 30 or equivalent circuit. Set resistors R2, R3, R5, and R6 in the counterclockwise position which gives minimum line current. Operate the CONTROL switch at the transmitter to the REMOTE position and request the operator at the remote point to place the distant channel selector switch in the channel 2 position. Adjust the VOLTAGE switch at the transmitter until the reading nearest 220 volts on the LINE VOLTS meter is obtained. Adjust the resistor in each of the lines until current readings closely approximating those shown in paragraph 44 for the correct position of the VOLTAGE switch are obtained. The two-tone telegraph equipment at the remote location provides for the adjustment of the line current of polar relay K1 in the transmitter.

(2) After the adjustments of the line compensating resistors have been made, make system tests from the remote position to assure that all circuit functions are performed satisfactorily. These tests should include operation of the transmitter for c-w telegraph transmission. For remote control of the transmitter, POWER switch S16 must be left in the ON position and CONTROL switch S2 must be left in the REMOTE position.

(3) Modulate the transmitter with the handset microphone or other suitable microphone at the remote control station. The observer at the transmitter should note the fluctuations in modulator space current under operating conditions of both strong and weak talkers. To make these tests, set the DC METER SWITCH to MOD. SPACE and observe the fluctuations of the meter from an initial reading of 20 to 80 ma up to about 250 ma.

h. Tuning Procedure with External Variable-frequency Oscillator. With the exception of tuning adjustments for the crystal-controlled oscillator, tuning adjustments of the transmitter when using an external variable-frequency oscillator are the same. When the EMISSION switch is in the EXT. OSC. position, the crystal-controlled oscillator is ineffective and the external r-f voltage is applied to the grid of the first r-f amplifier tube. The method of adjusting the transmitter using the external variable-frequency oscillator is described below:

(1) Set the EMISSION switch to EXT. OSC.

(2) Start the transmitter by operation of the POWER switch to ON and the CONTROL switch to CHANNEL 1.

(3) Set the external variable-frequency oscillator to the frequency necessary to yield the carrier frequency on which the transmitter is to work.

(4) Insert plug P1, used to terminate the shielded cable from the r-f source, into the jack marked EXTERNAL OSCILLATOR on the front of the transmitter. Operate the TEST KEY to the "carrier on" position.

(5) Set the DC METER SWITCH to P.A. SPACE and if an appreciable space current is indicated, adjust P.A. TUNING 1 to the setting which gives *minimum* current.

(6) Set the DC METER SWITCH to 1ST GRID and adjust the OSCILLATOR dial for maximum first amplifier grid current.

(7) Again set the DC METER SWITCH to P.A. SPACE and recheck for *minimum* power amplifier space current.

(8) Adjust the tuned plate circuits of the first and second amplifiers for maximum second amplifier and power amplifier grid currents, respectively, as previously outlined under subparagraph 4c, Tuning Procedure. For optimum performance, the first amplifier grid current should be between 0.6 and 1.0 ma with all tuning adjustments properly made and the transmitter working into a load. The adjustment for the first amplifier grid current should be made by the level control at the output of the external variable-frequency oscillator and not by detuning the OSCILLATOR dial. This dial must always be set for maximum first amplifier grid current.

> **CAUTION**: Be sure that any adjustment of the position of the plate tuning capacitors in either the first or second amplifier stages is followed by a check of the setting of P.A. TUNING 1 which gives *minimum* power amplifier space current.

The transmitter may now be used for c-w telegraph or telephone transmission.

SECTION III
FUNCTIONING OF PARTS

5. RADIO-FREQUENCY CIRCUITS. For complete schematic diagrams of these radio transmitters, refer to figures 27 and 29.

a. General. (1) In the description of the circuit functions of Radio Transmitters 33A and 34A, only those circuit elements forming a part of channel 1 are referred to in this section. The circuit elements used in channel 1 are identical to those used in channel 2. The r-f circuits of channel 1 are associated with the back contacts of channel switching relays K3, K4, K5, K6, and K11. The r-f circuits of channel 2 are connected to the common circuit elements of the oscillator and succeeding r-f amplifier stages through the closed contacts of these relays.

(2) Functional diagrams are used to illustrate important circuits, or partial circuits. Circuit constants for resistors and capacitors, when shown on these diagrams, are the nominal values specified for these components. Voltages indicated on these diagrams are approximations only, since they are dependent on commercial variations between transmitters and vary somewhat with different modes of transmission.

b. Crystal-controlled Oscillator. Refer to functional diagram (fig. 11) and transmitter schematic diagram (fig. 27 or fig. 29).

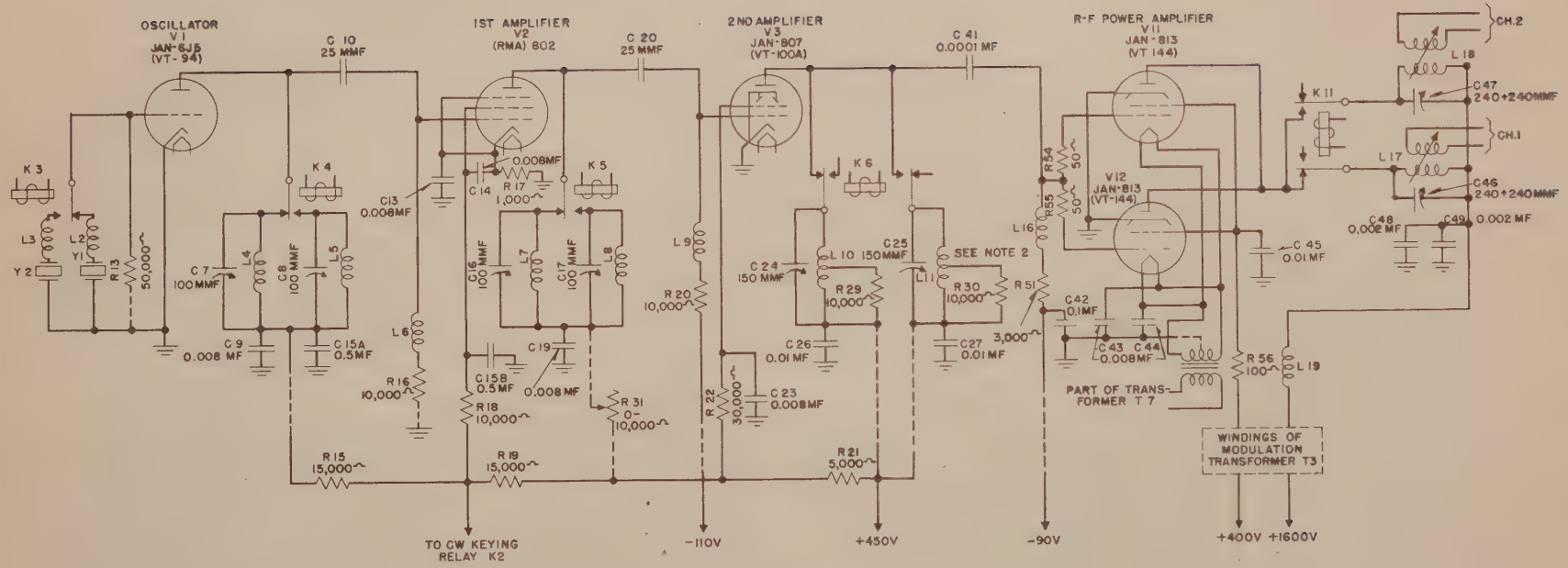
(1) The oscillator uses a Tube VT-94 heater-type triode V1 in a tuned plate—crystal grid oscillator circuit which depends upon interelectrode capacitance for feedback coupling. Crystal Y1 is between grid and ground and feedback occurs through the distributed capacitance from plate to grid. The fixed portion of the tuned plate circuit is inductor L4, whose inductance value depends on the setting of switch S5. Variable air capacitor C7, marked OSCILLATOR on the front of the set, in combination with L4, provides the means for tuning the oscillator. Inductor L2 in the grid circuit provides a small positive reactance in series with the crystal to increase its activity when capacitor C3 is bridged across it to obtain the required frequency shift in two-tone telegraph transmission.

(2) Grid bias for the oscillator is obtained by the action of grid leak resistor R13 when the tube is oscillating. When an external oscillator is used, Tube VT-94 (V1) is inactive and a d-c bias voltage is applied to the grid through contacts on switch S1B to prevent rectification of rf at the oscillator plate and grid.

(3) Plate voltage to the oscillator is supplied through a series of dropping resistors in the 700-volt plate supply circuit providing approximately 100 volts d-c at the plate of the tube. Capacitor C9 is an r-f bypass located in the shielded compartment. Capacitor C15A, in conjunction with resistor R15, comprises a signal shaping circuit to avoid steep wavefronts while keying the oscillator. Keying is accomplished by short-circuiting the plate supply through the back contact of relay K2.

(4) The plate circuit of the crystal oscillator is not tuned for a maximum grid current, but for 90 percent of the maximum value on the high-frequency side, that is, with less capacitance in C7 than is required for a maximum grid current reading. This method of adjusting the oscillator is essential to the satisfactory performance of the transmitter during high-speed keying operation.

c. First and Second R-f Amplifiers. (1) An 802 pentode and Tube VT-100A beam power amplifier are used as V2 and V3 in first and second r-f amplifier stages, respectively. Both stages are designed to operate efficiently as amplifiers or frequency doublers. When



NOTES:

1. RELAYS ARE SHOWN IN THE UNOPERATED POSITION WITH THEIR CONTACTS CLOSED FOR CHANNEL NO.1 OPERATION.
2. R 29 AND R 30 ARE CONNECTED ACROSS L 10 AND L 11, RESPECTIVELY, ON BANDS A, B AND C, AND ARE DISCONNECTED ON BAND D.
3. PARTIAL CIRCUITS ARE SHOWN FOR CONNECTIONS OF TUNED PLATE CIRCUITS TO RELAY CONTACTS AND FOR RETURN CIRCUITS TO GROUND THROUGH METER SHUNTS ETC., AS INDICATED BY DASHED LINES.

TL-11024

Figure 11. Radio-frequency circuits, functional diagram.

either the first or second r-f stage is used as a frequency doubler, its plate circuit is tuned to the second harmonic of the exciting voltage. In this way, crystal frequencies ranging from 2,250 to 4,500 kc may be used to yield a range in output frequencies between 3.0 and 13.0 mc. The relationship between the crystal frequency and the carrier frequency, and the functions of the first and second amplifier stages as either amplifiers or doublers with respect to these frequencies, are shown below.

(2) The plate of oscillator Tube VT-94 (V1) and the grid of first amplifier tube V2 are coupled by capacitor C10. R-f choke coil L6 is provided in the grid circuit of V2 to maintain a high impedance, looking into the grid of this tube. The proper bias voltage for the operation of this tube is obtained by the voltage drops across grid bias resistor R16 and cathode resistor R17. Meter shunt resistor R62 is used in the grid return lead to ground and may be connected to meter M2 through the contacts of switch S11 on the meter panel for measuring the grid current of the first amplifier tube.

(3) The tuned plate circuit of the first amplifier consists of inductor L7 and variable air capacitor C16 whose dial appears on the front of the set. BAND SWITCH S5B is connected to taps on the winding of L7 to give the proper value of inductance in this coil for tuning the output circuit of the first amplifier on each frequency band. Plate voltage for the first amplifier tube is supplied through inductor L7 and variable resistor R31. It is possible to vary the gain of the stage by adjusting the position of R31. Capacitor C15B and screen resistor R18 form an R-C circuit for shaping the keyed carrier on c-w telegraphy.

(4) The first and second r-f amplifiers are coupled by capacitor C20. Inductor L9 is provided as an r-f choke to maintain a high impedance, looking into the grid of second amplifier tube V3. Grid bias for this stage is obtained from both a fixed negative voltage supply and a drop across resistor R20. Tapped inductor L10 and variable air capacitor C24 provide the tuned plate circuit of the second amplifier stage. This circuit is similar to the tuned plate circuit of the first stage. The proper tap on L10 is selected by the setting of switch S5C. Resistor R29 is connected across a portion of inductor L10 to provide the proper terminating impedance for this stage when operating at frequencies in bands A, B, and C. The plate voltage for tube V3 is also controlled by switch S5C so that the gain of the second amplifier stage is adjusted to the proper value for each band.

d. R-f Power Amplifier. The r-f power amplifier uses two 813 tubes (V11 and V12) connected in parallel. Fixed bias on the grids of these tubes is obtained from a 90-volt tap on a voltage divider in the 110-volt bias supply circuit. R51 is a grid leak resistor which provides additional operating bias when r-f excitation is present. R-f choke coil L16 is used to maintain a high impedance, looking into the grids. C42 is provided as a bypass capacitor to exclude rf from the grid meter shunt and the 110-volt bias supply. The r-f power amplifier stage operates straight through at all frequencies. The r-f power amplifier is the only stage requiring changes in plug-in coil units (fig. 12) for the tuned plate circuit for different bands. Any one of three such plug-in units may be used for this purpose in circuit position L17. The tuning chart on the front of the transmitter shows the number of turns for each coil unit and identifies the coil used for any one of the four frequency bands. A strap

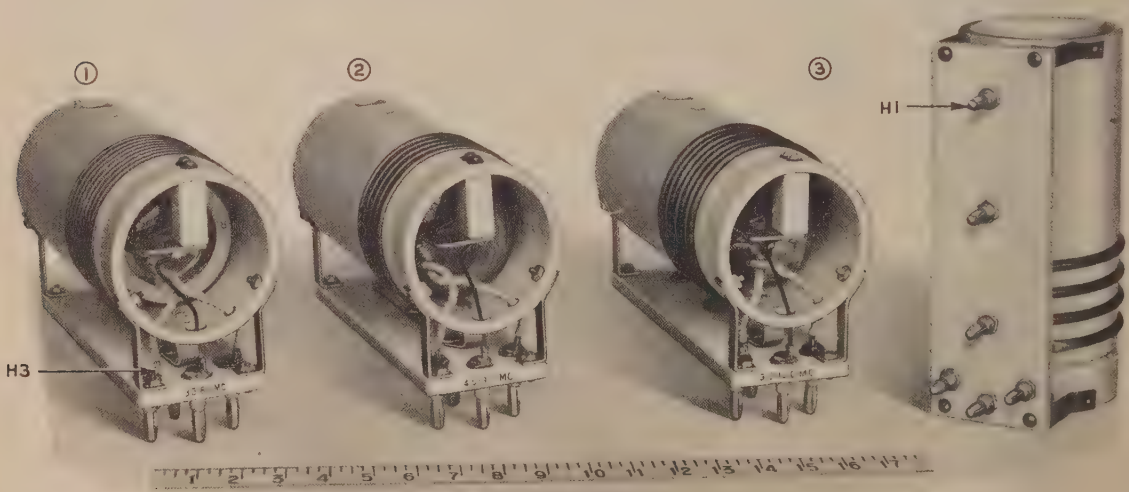
Band	*Crystal freq (kc)*		*Carrier freq (mc)*		*Multiplication of frequencies*		*Carrier in terms of crystal freq*
	From	*To*	*From*	*To*	*1st amplr*	*2d amplr*	
A	3,000	4,500	3.0	4.5	1	1	1f
B	2,250	3,000	4.5	6.0	1	2	2f
C	3,000	4,500	6.0	9.0	1	2	2f
D	2,250	3,250	9.0	13.0	2	2	4f

connection is provided in the base of the five- and nine-turn coil units. Tank capacitor C46 is made up of two sections. The strap connection in the base of the five- and nine-turn coil units connects these two sections of C46 in parallel when these coils are in place. An adjustable coupling coil inside the plate coil provides means for coupling to the antenna. It is designed to operate efficiently as a means of transferring power from the amplifier tubes to antennas varying over a wide range of impedances. The screens, as well as the plates, of the power amplifier tubes are modulated by separate windings on the modulation transformer in the audio amplifier panel. The r-f power amplifier is isolated from the audio amplifier at radio frequencies by means of choke coil L19 and resistor R56 in the plate and screen leads of the modulation transformer. Capacitors C48 and C49 serve as plate bypass capacitors in the power amplifier stage. Capacitor C45 performs a similar function in the screen circuit.

6. SPEECH INPUT CIRCUITS AND AUDIO AMPLIFIER.

a. Speech Input. The transmitter may be modulated by handset HS1 mounted on the front of the audio amplifier panel, or from a microphone at the remote control position. In the schematic diagram of Radio Transmitter 33A (fig. 28) and in the remote control circuit diagram (fig. 30) the handsets shown are identical. The microphone in the handset used in the transmitter location receives its d-c current from a low-voltage tap (approximately 1 volt) in the voltage divider of the 110-volt bias rectifier. Step-up in voltage from the microphone or speech input to the first stage is accomplished by input transformer T1 of the audio amplifier. Any balanced 500- to 600-ohm, two-wire telephone circuit providing a speech input level between —35 db and —10 db referred to 6 milliwatts reference level will provide substantially complete modulation.

b. Audio Amplifier. (1) Audio-frequency power to modulate the r-f power amplifier is furnished from a three-stage push-pull amplifier. Functional diagram (fig. 13) shows the circuit of this amplifier. By the use of push-pull connections in the three stages, distortion due to even-order harmonics and plate supply ripple is greatly reduced. [Two variable-mu Tubes VT-87 (V16 and V17) in a Class A amplifier circuit are used in the first audio stage.] This amplifier is transformer-coupled to the second stage using Tube VT-163 (V18) which consists of two



① COIL L17 OR L18, 3.0 TO 6.0 MC.
② COIL L17 OR L18, 4.5 TO 9.0 MC.
③ COIL L17 OR L18, 9.0 TO 13.0 MC.

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Figure 12. R-f power amplifier tuning coils.

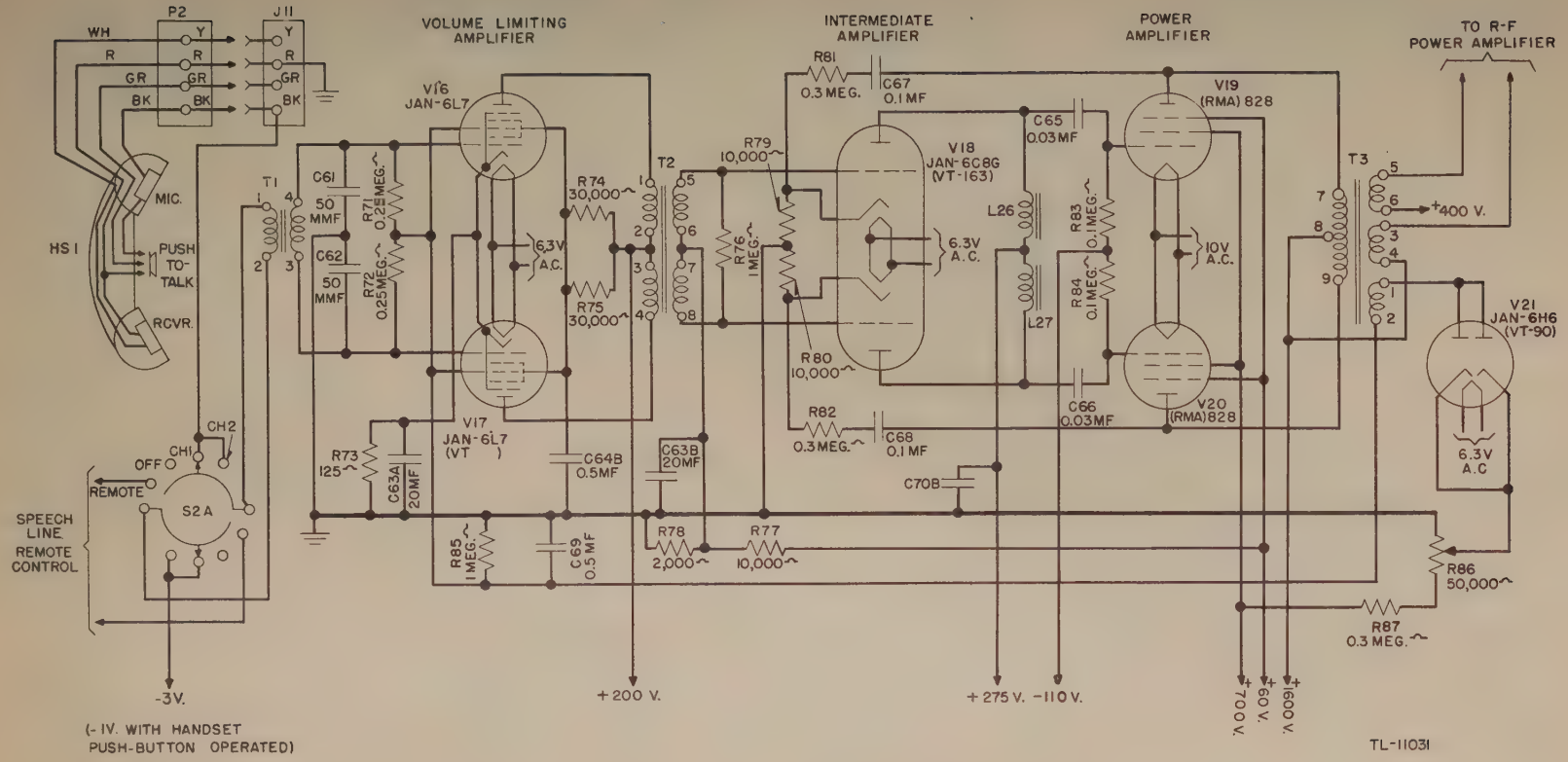
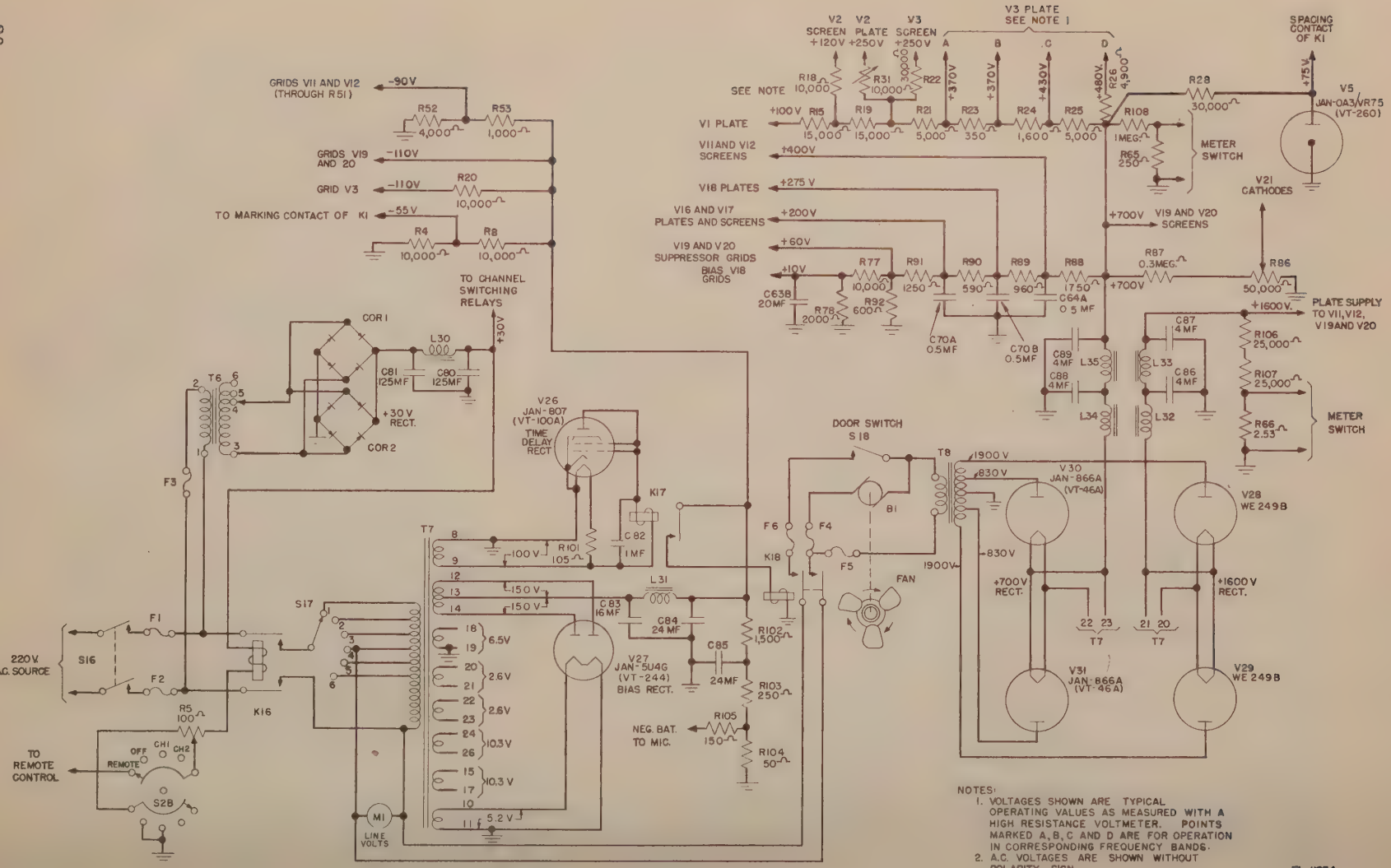


Figure 13.—Audio amplifier, functional diagram.



NOTES:
1. VOLTAGES SHOWN ARE TYPICAL OPERATING VALUES AS MEASURED WITH A HIGH RESISTANCE VOLTMETER. POINTS MARKED A, B, C AND D ARE FOR OPERATION IN CORRESPONDING FREQUENCY BANDS.
2. A.C. VOLTAGES ARE SHOWN WITHOUT POLARITY SIGN.

Figure 14. D-c power supply circuits, functional diagram.

voltage amplifier triodes in one bulb. It also functions as a Class A amplifier. The second stage is capacitance-coupled to the final audio-amplifier stage using two 828 pentodes, V19 and V20. An inverse feedback circuit is included between the last two stages which consists of C67, R81, and R79 in one side of the balanced circuit and C68, R82, and R80 in the other side. Capacitors C67 and C68 introduce negligible reactance and phase shift in the feedback voltage. Resistors R79 and R81 and resistors R80 and R82 form voltage dividers in each side of the balanced circuit. The portion of the output voltage to be fed back upon the input voltage is determined by the ratio of the two resistances in each of the voltage dividers.

(2) The last stage functions as a Class AB_1 modulator. At no time does the peak voltage applied to the grids of V19 and V20 exceed the fixed negative grid bias voltage. Consequently, these tubes draw no grid current. When the plate current is reduced or cut off for a portion of the negative grid swing on one of the tubes, the positive grid swing on the other tube supplies the missing portion of the output current waveform. Output transformer T3 of the last stage has three windings: two for modulating the plates and screens of the r-f power amplifier tubes and the third for volume limiter control.

(*a*) The volume limiter is provided to limit the audio voltages impressed on the screens and plates of the r-f power amplifier tubes to some predetermined value, thereby preventing over-modulation of the carrier. It does this by reducing the gain of the audio amplifier after the voltages developed at its output are at a sufficiently high level to produce 100 percent modulation of the carrier.

(*b*) The circuit of the volume limiter is shown as a part of the functional diagram of the audio amplifier (fig. 13). A twin-diode rectifier (Tube VT-90) is used in a half-wave circuit as the control tube. Its plates are connected to the No. 1 terminal of the control winding of transformer T3. The cathode bias on this tube is variable under control of resistor R86, which together with fixed resistor R87, is part of a voltage divider in the 700-volt plate supply circuit. R85 is a 1-megohm resistor connected between the other end of the control winding and ground. C69 is a 0.5-mf capacitor connected in parallel with this resistor, forming an R-C circuit. The negative end of this circuit is connected directly to the No. 3 grids of variable-mu Tubes VT-87 (V16 and V17) and to the No. 1 grids of these tubes through resistors R71 and R72.

(*c*) The volume limiter performs no useful function for small input voltages to the audio amplifier, when there is insufficient audio output power to produce 100 percent modulation. No current flows through the diode rectifier in this case, since the peak voltage across output terminals 1 and 2 of transformer T3 will be less than the cathode bias from resistor R86. Since under this condition no current will flow through resistor R85, the negative grid bias on the first amplifier Tubes VT-87 (V16 and V17) remains fixed, and the amplifier functions in the normal manner at maximum gain.

(*d*) When the speech input level is such that the output from the audio amplifier is just sufficient to modulate the carrier completely, approximately 100 volts peak will appear across output terminals 1 and 2 of transformer T3. One of the initial tests required in placing the transmitter in operation, or incidental to the replacement of Tubes VT-87 or VT-90 (V16, V17, or V21), is to adjust the setting of R86 so that when the full modulation capability is reached, a small rectified current will flow through rectifier Tube VT-90 (V21) and resistor R85, charging capacitor C69. The method of adjusting the position of R86 is described in paragraph 4**d**. The voltage across C69 is applied as increased negative bias to both the No. 1 and No. 3 grids of V16 and V17 (Tube VT-87), with the result that the gain of the first stage is reduced. Then, when the speech input level is reduced below the point required for complete modulation, no current is rectified by the diode and the amplifier again adjusts itself to full gain. The volume limiter is prevented from varying the bias on the controlled tubes at audio frequencies by time constant circuit R85 and C69. This circuit is designed to hold over changes in speech signals of short duration and permits the volume limiter to become effective only during sustained passages of speech above higher than normal input levels. As a result,

the volume limiter adjusts the percentage modulation to approximately the same level for both weak and strong talkers and at the same time provides adequate protection against over-modulation of the carrier.

7. POWER CIRCUITS.

a. Types of Rectifiers Used. The d-c supply circuits and the purposes for which they are used may be classed as follows:

Nominal voltage	*Type of circuit*	*Use*
+ 30	Full-wave copper oxide rectifier.	Relays
− 110	Full-wave—high vacuum rectifier.	Tube bias
+ 700	Full-wave—mercury-vapor rectifier.	Plate supply to low power tubes
+1,600	Full-wave—mercury-vapor rectifier.	Plate supply to high power tubes

b. Operation of Power Circuits. Refer to the functional diagram of the d-c power supply circuits (fig. 14).

(1) Primary power to the transmitter is controlled by toggle switch S16 located on the front set. When this switch is turned to ON, it immediately energizes transformer T6 and its associated rectifier, consisting of two rectox units, COR1 and COR2, connected in parallel. Taps are provided on the secondary winding of this transformer to permit an adjustment of the voltage applied to the rectox units. These units are connected to the lowest voltage tap on the transformer in new transmitters. Should the rectifier show a falling off in the d-c voltage after a year or two of operation, the tap connection may be changed to obtain a greater part or the full voltage developed across the secondary winding. Satisfactory performance of the relays used in the transmitter depends upon proper output voltage of this rectifier.

(2) Load on the low-voltage rectifier depends on the current drain through relays under different circuit conditions and is greater for operation on channel 2 than on channel 1. The output voltage of the rectifier under the two conditions of operation will vary about 10 volts. The output voltage of the rectifier is also dependent upon the line voltage of the primary source. The relation between the line voltage and rectifier voltage for different load conditions is given in paragraph 43. The d-c current for operating relays is filtered by a choke-capacitor pi section filter, consisting of inductor L30 and capacitors C80 and C81.

(3) When switch S16 is in the ON position and switch S2 is set either to CHANNEL 1 or CHANNEL 2, relay K16 operates and closes the line circuit to the power supply tap switch S17 and transformer T7. S17 permits adjustment of the line voltage connection to one of six taps on transformer T7. By means of this switch the voltage across the primary of the transformer may be adjusted to approximately 220 volts at tap 4, and the voltage to the primary side of high-voltage transformer T8 will have the same value. Ac is used for heating tube filaments and cathodes, all being supplied from transformer T7. Transformer T7 also energizes 110-volt bias rectifier Tube VT-249 (V27), and supplies 100 volts to time delay Tube VT-100 (V26). When the heater of this tube has been in operation for approximately 20 seconds, sufficient rectified current will flow through the plate and grids connected in parallel to operate relay K17. *For day-to-day operation, this delay provides the required heating time for the filaments of the high-voltage mercury-vapor rectifier tubes before anode voltage is applied. However, in the initial testing of the transmitter, or after mercury-vapor tubes have been subjected to handling or prolonged standing, a filament heating period of at least 30 minutes is required.*

(4) If the door switch S18 is closed, operation of relay K18 completes the line circuit to transformer T8 and fan motor B1. Transformer T8 supplies plate potential to both 700-volt rectifier tubes V30 and V31 (866A) and 1,600-volt rectifier tubes V28 and V29 (249B). Both sets of tubes operate as full-wave rectifiers. The voltage drop in the mercury-vapor tubes is low and is practically independent of the load current. Consequently, good regulation is obtained under the various load conditions imposed on these rectifiers. The output of each of the rectifiers is filtered by two series inductors in each positive lead and two capacitors between the load side of each inductor and ground. At the output end of each filter, meter shunt resistors forming a part of a

voltage divider circuit are provided for measuring the plate voltage. In the 700-volt plate supply circuit, additional resistor-capacitor filters are used in the form of a voltage divider, thereby providing additional filtering action in the plate supply circuits to the low-power tubes.

(5) In the voltage divider panel of Radio Transmitter 34A, only those circuit elements needed to maintain the proper load conditions and the proper filtering action on the 700-volt rectifier are used. These items, shown in schematic diagram (fig. 29), are resistors R88 to R92, inclusive, and capacitor C64. These items are duplicates of the corresponding circuit elements of the audio amplifier of Radio Transmitter 33A and bear the same reference numbers. They are illustrated in the bottom view of the voltage divider panel (fig. 15).

(6) Fuses F1 and F2 are connected in series with the primary power supply leads. Other parts of the power supply circuit are fused separately. Fuse F3 is connected in series with the primary winding of transformer T6, and fuse F4 is similarly connected in the circuit of the fan motor. Fuse protection for the high-voltage rectifiers is accomplished by fuses F5 and F6 in both sides of the line to transformer T8.

8. RELAY CONTROL CIRCUITS.

a. General. A functional diagram of relay control circuits is shown in figure 16. The functions performed by relays in controlling the transmitter, except for the two relays (K1 and K2) used in keying the transmitter, may be classified as follows:

(1) Control of primary power.
(2) Channel switching.
(3) Protection.

Operation of relays K1 and K2 for two-tone and c-w telegraph transmission are described in paragraph 9. Control of main power relay K16 and channel switching relay K7 are transferred to the remote control position when CONTROL switch S2 is in the REMOTE position. The method of operating these relays is the same from the remote point as from the transmitter. Resistors are connected in series with each winding, however, when operated locally. A portion of the resistors in series with the relay windings may be short-circuited when switch S2 is in the REMOTE position, thus permitting an adjustment of the operating current to the same value for remote control of the transmitter as for local control.

b. Detailed Circuit Functions. Refer to functional diagrams (figs. 14 and 16).

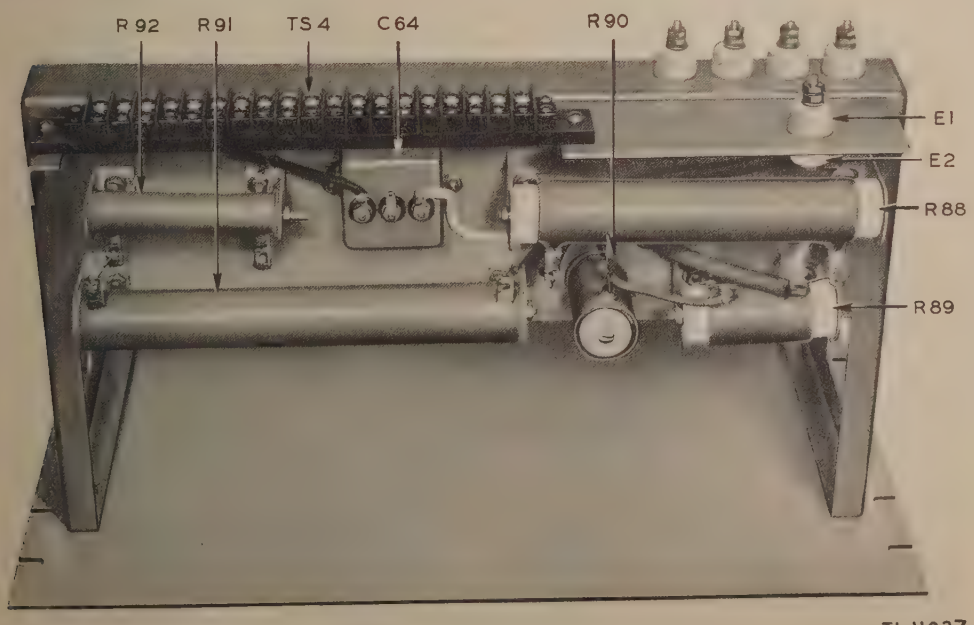


Figure 15. Voltage divider panel, bottom view.

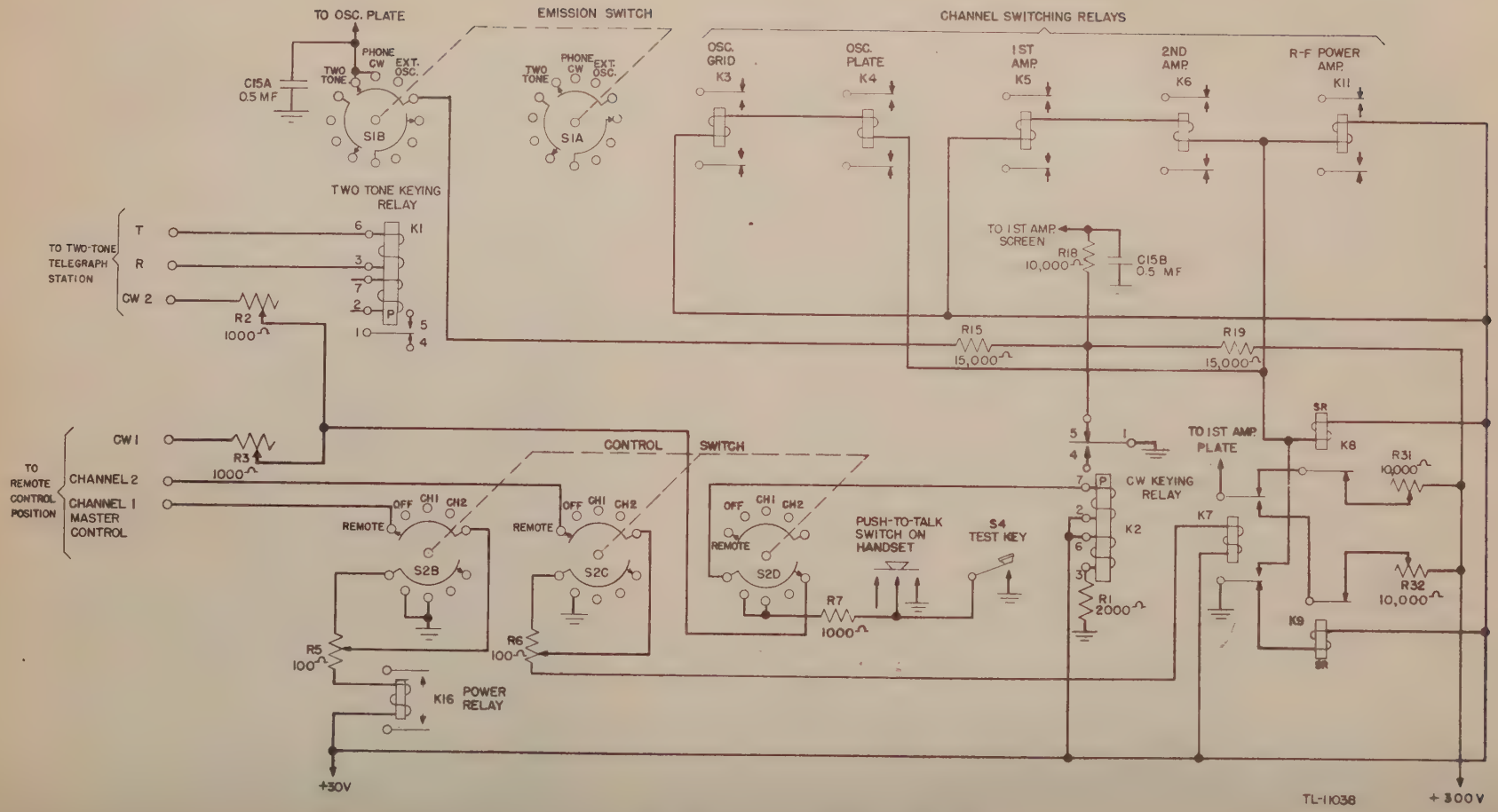


Figure 16. Relay control circuits, functional diagram.

(1) The functions of the various relays are described as if operated by the controls at the transmitter. Operation of POWER switch S16 to the ON position energizes the 30-volt d-c rectifier and makes current available for operating relays. When CONTROL switch S2 is placed in either the CHANNEL 1 or CHANNEL 2 position, relay K16 is energized and closes the line circuit to transformer T7. Relay K17 is energized by the rectified plate current from time delay tube V26 (807) which depends on the heating time period of the heater and cathode. With the supply line voltage adjusted to 220 volts, the time delay between operation of the CONTROL switch and operation of relay K17 is approximately 20 seconds.

(2) Relay K18 receives its operating current from the 110-volt grid bias rectifier and operates as soon as the time delay circuit has functioned. Relay K18 then closes the a-c line to the primary winding of transformer T8 if door switch S18 is closed.

(3) Channel switching relays K3 to K7, inclusive, and K11 remain unoperated when the CONTROL switch is in the CHANNEL 1 position. Under this condition the r-f circuits are closed through the normally closed contacts of the relays in the unoperated position for channel 1 operation. When the CONTROL switch is set to CHANNEL 2, relay K7 operates, which in turn operates all other channel switching relays. This transfers the tuned r-f circuits to the transmitting condition for channel 2 operation. The channel switching relays not only perform functions of associating the correct tuned circuits with the plates of the oscillator, intermediate amplifiers, and power amplifier for the particular channel used, but they also short-circuit the tuned circuits of the unused channel.

(4) Relay K11 in the r-f power amplifier circuit has high level r-f voltages applied across its contacts and between the contacts and ground. The contact separation and spacing between the relay members is not great enough to withstand arc-over from the high voltage developed in the tank circuit of the power amplifier, if switching operations are performed with the carrier on. A time delay circuit is used which cuts off the r-f voltage during the interval required for changing from one channel to the other. This time delay circuit uses two fast operate-slow release relays which are operated in a local circuit from relay K7. Relays K8 and K9 used for this purpose are equipped with a ½-inch copper slug on the core adjacent to the relay winding.

(5) When the CONTROL switch is in the CHANNEL 1 position, relay K7 is unoperated. A circuit is closed through one of the back contacts on K7 which energizes the winding of relay K9. This relay remains operated as long as K7 is in the unoperated position. The plate circuit to first amplifier tube V2 is at this time closed through variable resistor R31, back contact of relay K8, and back contact of relay K7.

(6) A change in the position of the CONTROL switch from CHANNEL 1 to CHANNEL 2 causes relay K7 to operate, opening the plate circuit to the first amplifier tube. The r-f circuit is effectively blocked by the first amplifier tube at the instant relay K7 leaves its back contact. K7 also opens the circuit through the winding of K9. This relay, however, does not release for a short interval of time after its winding is open circuited. During this interval no voltages are applied to the inputs of the second amplifier or the power amplifier, and K11 operates with no r-f voltages to break. When relay K9 releases approximately 0.1 second later, the plate supply circuit to the first amplifier tube is again closed. This circuit may be traced through variable resistor R32, back contact of relay K9, and make contact of relay K7.

(7) A similar cycle is performed by relays K7, K8, and K9 upon a change in the position of the CONTROL switch from the CHANNEL 2 to the CHANNEL 1 position. In that case the plate circuit to the first amplifier is held open for a short interval by the back contact of relay K8. During this time relay K11 is permitted to release.

9. C-W AND TWO-TONE TELEGRAPH OPERATION.

a. C-w Keying Operation. (1) Current flows through the 3-6 winding of polar relay K2 (fig. 16) at all times the 30-volt rectifier is in operation. When this winding alone is energized, the relay armature is held on its *spacing* or left contact (No. 5). This places a

ground on the common point of resistors R15, R18, and R19, which effectively grounds the positive voltage supply to the plate of oscillator V1 and screen grid (G2) of first amplifier V2; consequently, no carrier is transmitted. Depressing the telegraph key closes ground over the CW 1 or CW 2 leads through the 2-7 winding of relay K2 to +30 volts. This causes a current flow in the 2-7 winding of approximately twice the value of the current flow in the 3-6 winding and since the polarity of the two windings is reversed, the field of the relay reverses its magnetic polarity and causes the relay armature to move to its *marking* or right contact (No. 4). This removes the ground from the oscillator plate and first amplifier screen grid circuits and permits these tubes to perform their normal functions and place r-f drive on the following stages.

(2) Capacitor C15A is associated with the plate circuit of the oscillator as a means for controlling the build-up and hang-over time periods of the carrier while keying the transmitter. This capacitor prevents a sharp increase in the amplitude of the carrier wave when the telegraph key is depressed. Also, when the key is released, the carrier does not go off immediately, but gradually decreases as the charge on C15A leaks off through resistor R15 and the oscillator load. Capacitor C9 is connected in parallel with C15A and mounted close to the r-f circuit. It is required to bypass r-f currents and keep them out of the power supply circuits. Capacitor C15B is used as a part of the shaping circuit in the first r-f amplifier. This capacitor is associated with resistor R18 to prevent an abrupt change in the screen voltage at the time the telegraph key is either depressed or released.

b. Two-tone Telegraphy. The frequency of the crystal-controlled oscillator is shifted for two-tone telegraph operation by adding capacitance across the crystal circuit as shown in figures 17, 28, and 29. A small inductance L2 (for channel 1) is connected in series with crystal Y1 to provide a circuit which will react with parallel capacitor C3 to change the oscillator frequency by the required amount (850 cycles at 3 mc). Capacitor C3 is connected effectively from the oscillator grid to ground when the double-diode rectifier V5 (Tube VT-90) is conducting as the result of the low impedance of this tube under that condition, and is substantially disconnected for r-f purposes when the diode is not conducting by virtue of the very low capacitance of the diode elements. The conductivity of the diode is controlled by applying positive or negative d-c voltage through isolating resistor R11 by means of polar relay K1. This relay is operated by the external telegraph equipment. Resistor R12 and capacitor C2 are provided to prevent transients due to relay contacts from being transmitted through the r-f circuits. The voltage regulator Tube VT-260, in circuit position V4, is used to regulate the positive d-c supply to the diode rectifier, which requires about 5 ma d-c in the conducting condition. The amount of grid current produced by the oscillator varies under different conditions of two-tone telegraph operation. The current observed

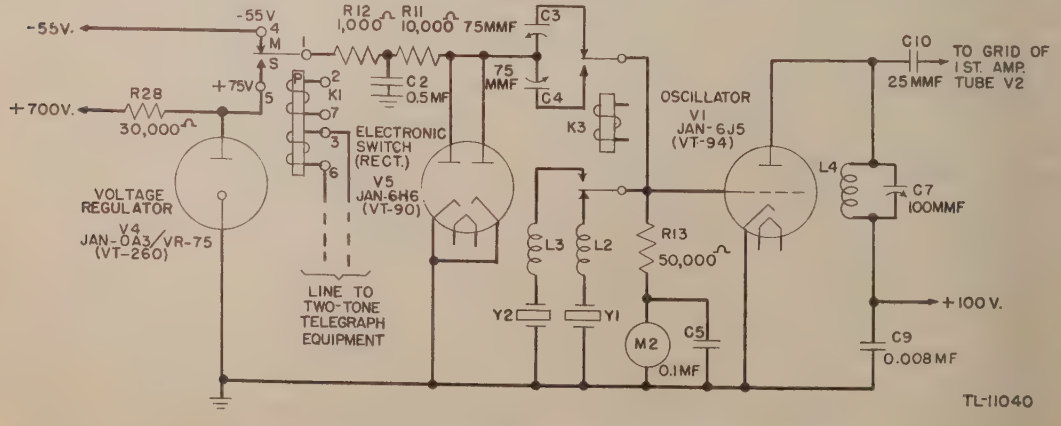


Figure 17. Two-tone telegraph keying circuits, functional diagram.

on DC METER during the *marking* period will usually be between 0.5 and 1.5 milliamperes. The activity of the crystal is reduced by bridging capacitor C3 during the *spacing* period, particularly when an 850-cycle shift in the frequency of oscillation is required. Under this condition the oscillator grid current may be observed to fall to a very low value and the first amplifier grid current may be reduced. However, the excitation voltage is sufficient to drive the following r-f amplifiers to maintain full output power of the transmitter for both *marking* and *spacing* signals. The transmitter should never be used for telephone or c-w telegraph transmission with the EMISSION switch set to the TWO TONE position, except as indicated in section I, paragraph 1**g**.

10. OPERATION WITH EXTERNAL VARIABLE-FREQUENCY OSCILLATOR.

When an external variable-frequency oscillator is used as the source of r-f voltage, connection is made to the transmitter through jack J3 on the front of the set. With the EMISSION switch set to the EXT. OSC. position, the circuit is closed between the source of excitation and the grid of first amplifier tube V2 through coupling capacitor C11. With the EMISSION switch in this position, the plate voltage supply to oscillator tube V1 is opened, and in addition a high negative bias is applied to the grid of this tube so that any r-f voltage from the external oscillator will not be rectified by this tube. This circuit feature is provided to prevent a false indication of oscillator grid current while the transmitter is being operated with an external variable-frequency oscillator. Operation of the r-f circuits of the transmitter is the same when using the external variable-frequency oscillator as from the crystal-controlled oscillator, except that the oscillator tuning adjustment serves as the means for tuning the input circuit of the first amplifier stage. When the transmitter is operated from the external variable-frequency oscillator, only the first r-f amplifier is effective in blocking the carrier during the *spacing* period on c-w telegraph transmission. Therefore, the keyed carrier impulse will vary in shape somewhat from that obtained when using the crystal-controlled oscillator.

SECTION IV
MAINTENANCE

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W.D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). If Form No. 468 is not available, see TM 38–250. Failure or unsatisfactory performance of equipment used by the Army Air Forces will be reported on Army Air Forces Form No. 54 (unsatisfactory report).

11. GENERAL.

Radio Transmitters 33A and 34A are designed to give long, trouble-free service. However, like any radio equipment, they should be given a routine inspection at regular intervals. This paragraph describes some of the points to check during these inspections. The scope of the inspection may be enlarged if there is evidence that routine check is not picking up general troubles prior to service failure.

a. Vacuum Tubes. All vacuum tubes have a limited life and unless ultimate failure is anticipated, service may be interrupted. All vacuum tubes in the transmitter are operated below their RMA CCS (Radio Manufacturers Association continuous commercial service) ratings which should give them long life. However, the best assurance against tube failure is to keep careful records of hours of service and meter readings. The tube records should show the date of installation and number of hours during which plate voltage was applied to the tubes. The transmitter should be checked regularly on all frequencies used on both channels and meter readings compared with station records and paragraph 42, Typical Meter Readings. Symptoms of faulty performance should be entered in the station log book in order that the operator may be warned in advance of impending tube failure.

b. Relays. The various relays used in this transmitter have coils and contacts with voltage and current ratings exceeding any condition encountered in normal operation. Contact arcing has been eliminated by filter networks as much as possible. However, the relays should be inspected at regular intervals with special attention given to dirty or corroded contacts and circuit operation. Dirt or foreign matter in other parts of the relays also causes trouble. For instance, dirt or foreign matter, such as iron filings between the armature and pole pieces of relays K1 or K2, may interfere with keying the transmitter even though all circuits and tubes check O. K. Dirt under the armature of relays K8 or K9 may cause them to release rapidly and lessen protection of relay K11 contacts when switching channels. This may result in an r-f arc at K11 and blown fuses, even though all other apparatus tests O. K. The steps required for adjusting relays are outlined in paragraph 39 of this section.

c. Fan and Air Filter. Periodic inspection of the cooling system is essential if dirt troubles as outlined above are to be avoided. All resistors in the set have a wattage rating well in excess of any condition encountered in normal operation. However, this rating is based on the free circulation of air and overheating may result if the air filter becomes clogged with dirt. *Approximately 1.5 kilowatts of power is dissipated as heat when Radio Transmitter 33A is operating.* Check the fan and filter as outlined in paragraph 37.

d. General Condition of Equipment. Every precaution has been taken to provide finishes on the various parts, impregnation of resistors, coils, and isolantite parts, potting of transformers and capacitors, etc., to make a transmitter which will give good service under adverse temperature and humidity conditions.

The routine inspection should include a general inspection of wiring, chassis, terminals, capacitors, knobs, etc., to insure that all parts are working properly, screws are tight, connections are not corroded, rust is not forming, tubes are secure in sockets, etc. The scope of this inspection should be enlarged to cover additional points where the transmitter is operating under extremes of temperature or humidity.

12. TROUBLE SHOOTING.

a. The information in the following paragraphs is for use as a guide in clearing ordinary troubles which may be encountered in the installation or normal operation of the transmitter. It is assumed that the steps outlined in section II have been followed and that some part or circuit in the transmitter has failed to function as outlined, or that characteristics of the transmitted signal have changed to a point which requires remedial action.

b. If the transmitter has been operating satisfactorily, the station record of meter readings and dial settings provides a basis for isolating the particular circuit in trouble. This record also aids in anticipating troubles due to aging of tubes and other apparatus.

c. If trouble is encountered during the initial installation and tuning of the transmitter, paragraph 40, Tuning Chart and paragraph 42, Typical Meter Readings are of assistance in isolating defective circuits. These dial settings and meter readings are *approximate* and represent an *average* of

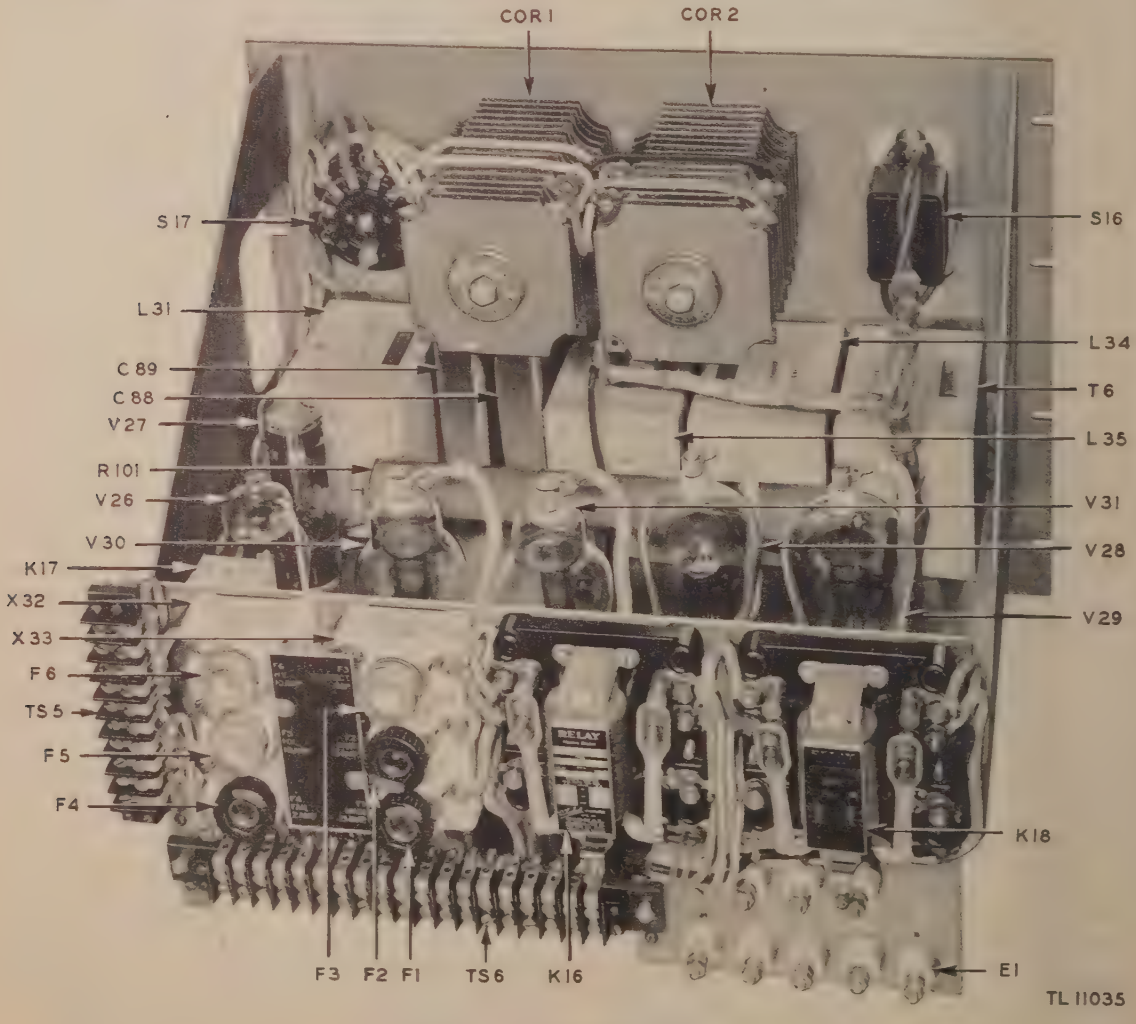


Figure 18. Power panel, top view.

many transmitters. The actual meter readings and dial settings obtained are subject to variation from those shown in the tables due to normal variations of tubes, resistors, capacitors, transformers, or the a-c power source.

d. *Caution* should be observed at all times and doubly so when clearing circuit troubles. Bodily contact with the 1,600-volt or 700-volt plate power supply, or even the 220-v a-c power leads, may prove fatal. *Keep one hand in your pocket. Discharge the high-voltage filter capacitors by short-circuiting the 1,600-volt capacitors and grounding the the 700-volt terminal on the power panel with an insulated-handle screwdriver, before working on any part of the transmitter. Never* work on the transmitter *alone.* Have an assistant stand by at the main power switch. Remember that the 220-v a-c power circuit and the 110-v d-c bias circuit may be on when the rear door is open. When it is necessary to observe the mercury rectifier or voltage regulator tubes under load with the rear door open, the door switch may be momentarily shorted with a tool, such as the screwdriver mentioned above, while the assistant turns the main power switch on and off. *Stand back from the transmitter and do not touch any part of it or any ground. Never* put a temporary or permanent short circuit on the door switch or its associated wiring. Make

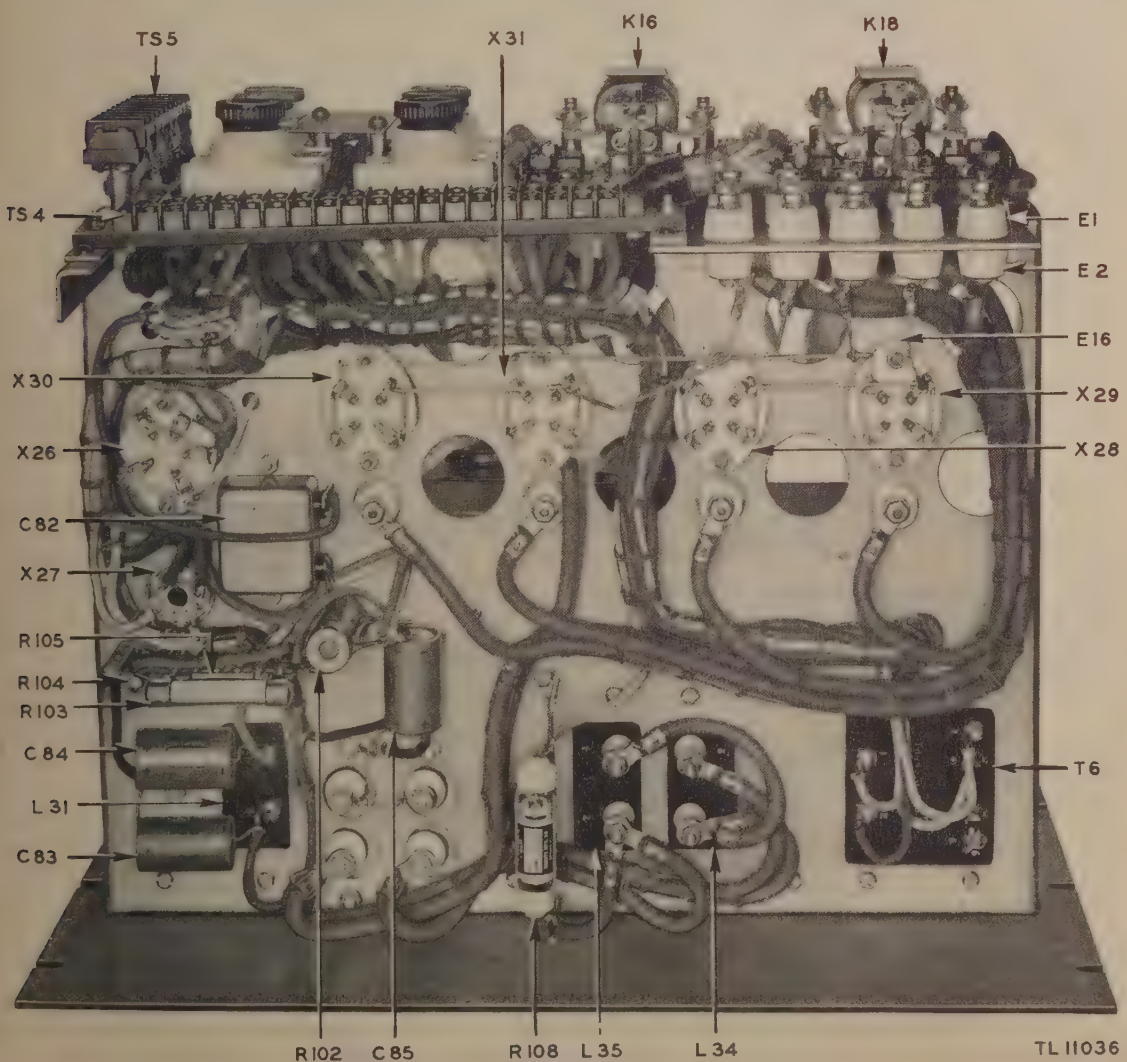


Figure 19. Power panel, bottom view.

all voltage tests which require the plate power supply to be on, with the voltmeter *outside* of the transmitter and the rear door closed. Connect the voltmeter with well-insulated wires which may be run through the openings in the door. Make all resistance tests with the main power switch off unless otherwise specified; then use *extreme caution.*

e. The trouble conditions listed are basic troubles and not necessarily exact conditions encountered in operation of this transmitter. They are a guide in locating actual trouble conditions. Some circuits in the following outline may come under two or more headings, but they are covered in more detail under the heading concerning the related apparatus. The various POSSIBLE CAUSES and the associated tests and remedies (PROCEDURE) are listed in the most logical order possible. They should be followed step-by-step in clearing any given trouble condition.

13. CHANNEL NO. 1, MASTER CONTROL CIRCUITS, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

Filaments and pilot lamp do not light with CONTROL switch on CHANNEL 1.

POSSIBLE CAUSE	PROCEDURE
1. 220-v a-c power is OFF.	1. Check power panel terminal Nos. 13 and 14 with a-c voltmeter.
2. Fuse F1 or F2 blown.	2. Inspect fuses; replace if defective.
3. 30-v a-c power OFF; fuse F3 blown.	3. Inspect fuse F3; check d-c voltage at power panel terminal No. 20. Refer to paragraphs 18 to 22 for power supply trouble.
4. Relay K16 winding open; cable terminals loose; defective switch S2B or resistor R5.	4. Make resistance or voltage tests at power panel terminal No. 22 and driver panel terminal No. 14; replace defective parts.

B. SYMPTOM:

No plate voltage with CONTROL switch on CHANNEL 1; filaments and pilot lamp lighted.

POSSIBLE CAUSE	PROCEDURE
1. Relay K18 not operating.	1. See paragraphs 18 to 22 for power circuit trouble.
2. Fuse F5 or F6 blown.	2. Inspect and replace if defective. See paragraphs 18 to 22 for power circuit trouble.

14. CHANNEL NO. 2 CONTROL, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

R-f circuits do not transfer with CONTROL switch on CHANNEL No. 2.

POSSIBLE CAUSE	PROCEDURE
1. Interconnecting cable leads transposed or not connected.	1. Check voltage at driver panel terminal No. 20; correct wiring if required.

2. Open winding on relay K7; defective resistor R6 or switch S2C.	2. Check voltage at R6 (left terminal); replace defective parts.
3. Dirty contacts on relay K7; foreign matter under armature; relay adjustment.	3. Clean contacts and pole piece or adjust relay as outlined in paragraph 39.

B. SYMPTOM:

Part of r-f circuits do not transfer with CONTROL switch on CHANNEL No. 2.

POSSIBLE CAUSE	PROCEDURE
1. Open winding on relays K3 to K6 or K11.	1. Check resistance at driver panel terminal No. 15 (all tests) and p-a panel terminal No. 7; observe relay K11.
2. Foreign matter under relay armatures; dirty contacts; relay adjustments.	2. Inspect relays in driver and p-a panels, clean and adjust as outlined in paragraph 39.
3. Wiring reversed or transposed at driver or p-a panels.	3. Check wiring; correct as required.

15. SLOW RELEASING RELAYS K8 AND K9, TROUBLE-SHOOTING CHART.

SYMPTOM:

Arcs form at relay K11 when channels are transferred.

POSSIBLE CAUSE	PROCEDURE
1. Relays K8 or K9 or both are not releasing slowly; foreign matter between armature and core; relay adjustment; dirty contacts on relay K7; open windings on relays K8 or K9.	1. Check operation of relays K8 and K9 and clean or adjust as outlined in paragraph 39.

16. CARRIER CONTROL RELAY K2, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

Operation of test key S4 does not turn on carrier.

POSSIBLE CAUSE	PROCEDURE
1. Open winding (2-7) on relay K2; open resistor R7; defective switch S2D.	1. Check resistance and voltage at drive panel terminal No. 11 (all tests); transfer relay K1 to jack J2 in place of K2 and recheck; replace defective parts.
2. Contacts sticking on relay K2; relay adjustment.	2. Clean contacts and adjust relay if required as outlined in paragraph 39.
3. Foreign matter between K2 armature and pole pieces.	3. Clean relay as outlined in paragraph 39.

B. SYMPTOM:

Carrier on steady.

POSSIBLE CAUSE	PROCEDURE
1. Open winding (3-6) on relay K2; open resistor R1.	1. Check resistance at J2 terminal No. 3 and K2 relay winding; replace if defective.
2. Contacts sticking on relay K2; relay adjustment.	2. Clean and adjust if required, as outlined in paragraph 39.
3. Foreign matter between armature and pole pieces on relay K2.	3. Clean as outlined in paragraph 39.
4. Loose connection or corroded jack spring at J2 terminal Nos. 1 and 5.	4. Inspect jack and wiring and check for *NO VOLTAGE* at oscillator plate (C15A) with TEST KEY S4 normal and transmitter power on.
5. Spurious oscillations in r-f circuits.	5. See paragraph 23 for procedure.

17. REMOTE CONTROL CIRCUIT, TROUBLE-SHOOTING CHART.

SYMPTOM:

Channel and carrier control circuits do not function from remote point.

POSSIBLE CAUSE	PROCEDURE
1. A-c line voltage dropped or +30-v supply failed.	1. Check transmitter in both channels with local controls; see paragraph 23 for power circuit failure.
2. Control line trouble or failure; improper setting of resistor R2, R3, R5, or R6.	2. Check line currents and proceed as outlined in paragraph 3c.

18. THIRTY-VOLT POWER SUPPLY CIRCUIT, TROUBLE-SHOOTING CHART.

This power supply consists of a power transformer, copper-oxide rectifier with two units operating in parallel, filter choke, and two filter capacitors. The transformer has three taps on its secondary which provide higher a-c voltages to compensate for aging of the rectifier units. The electrolytic capacitors used in the filter are also subject to aging and deterioration which may cause lower internal resistance or lower capacitance, or both. Since aging of either the capacitors or the rectifier may cause a drop in the output voltage, it is necessary to determine which unit is in trouble when this voltage falls below a point which interferes with the normal operation of the control circuits. The following are considered indications of equipment failure in this circuit:

SYMPTOM:

Voltage too low.

POSSIBLE CAUSE	PROCEDURE
1. C80 and C81 resistance too low; capacitors defective.	1. 0.25 amp d-c load on rectifier with all other load removed; test at the power panel terminal No. 15.
2. C80 and C81 capacitance too low; capacitors faulty.	2. Ripple in output causes chatter or hum in relays or irregular operation of K2.

3. COR1 and COR2 output too low; rectifiers defective.	3. Less than 22v dc at power panel terminal No. 20 with transformer T6 tapped at No. 6, transmitter operating on channel No. 2 with carrier on and line voltage of 200v ac as measured at 220-v a-c terminals on main terminal strip TS1.

19. FILAMENT POWER SUPPLY, TROUBLE-SHOOTING CHART.

A. SYMPTOM:
All tubes and pilot lamp fail to light.

POSSIBLE CAUSE	PROCEDURE
1. Dirty or burned contacts on relay K16.	1. Check a-c voltage at contacts; clean and burnish as required. CAUTION: Turn a-c power off at switch S16 before touching contacts.
2. Defective contact on switch S17.	2. Turn S17 to a lower numbered contact and recheck filaments; replace switch if defective.
3. Defective transformer T7.	3. Remove transformer and check resistance of all windings; replace defective unit.

B. SYMPTOM:
One or more tubes fail to light or heat up.

POSSIBLE CAUSE	PROCEDURE
1. Tube burned-out; filament or heater circuit grounded.	1. Check for a-c volts at heater (H) or filament (F) terminals of socket; replace defective tubes.
2. Transposed or reversed wiring at panel terminal strips.	2. Check filament or heater voltages at corresponding panel terminal strip; check wiring (fig. 32); correct as required.
3. Defective transformer T7.	3. Check voltage at T7 terminals; replace defective transformer. CAUTION: A line voltage of 220-v ac and bias rectifier voltages of 300-v ac are exposed on T7 terminal plate.

20. TIME DELAY CIRCUIT, TROUBLE-SHOOTING CHART.

A. SYMPTOM:
Relay K17 does not operate.

POSSIBLE CAUSE	PROCEDURE
1. V26 (807) burned-out or deactivated.	1. Check V26 for heated cathode; replace with new tube and recheck.
2. Winding (8-9) of T7 open.	2. Check a-c voltage at power panel terminals No. 2 and No. 18; replace defective T7.
3. Resistor R101 open.	3. Check voltage at V26 socket terminal No. 5; replace defective resistor.
4. Relay K17 winding open; C82 shorted or grounded.	4. Check resistance at V26 plate cap; replace defective relay or capacitor.

B. SYMPTOM:

Relay K17 chatters.

POSSIBLE CAUSE	PROCEDURE
1. Defective tube V26.	1. Replace V26 (807) and compare results.
2. Capacitor C82 open.	2. Connect new capacitor between power panel terminal No. 18 and V26 plate and compare results; replace defective parts.
3. Relay adjustment.	3. Readjust as in paragraph 39.

C. SYMPTOM:

Relay K17 takes more than 30 seconds to operate.

POSSIBLE CAUSE	PROCEDURE
1. Defective tube V26.	1. Replace V26 (807) and compare.

21. BIAS SUPPLY CIRCUIT, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

K18 fails to operate; voltage at power panel terminal No. 3 below —90 volts.

POSSIBLE CAUSE	PROCEDURE
1. Defective rectifier tube V27 (5U4G); filter capacitor C83, C84, or C85; bias circuit grounded.	1. Check resistance at power panel terminal No. 3 (all tests); if normal, replace V27 (5U4G); if below normal, isolate panel by opening bias feeder to other panels; replace parts found defective.

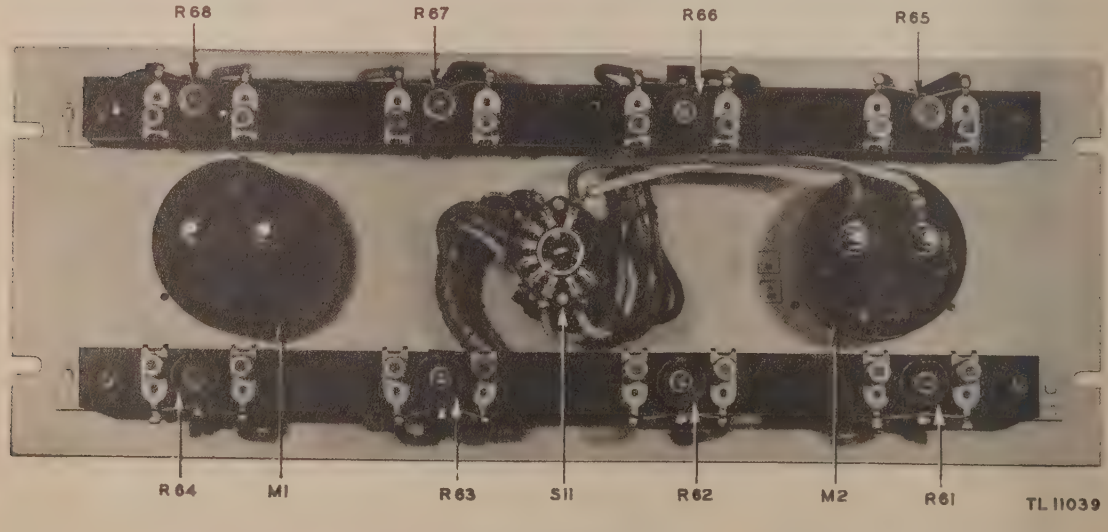


Figure 20. Meter panel, rear view.

2. Open winding on bias filter choke L31.	2. Check for d-c volts and resistance power panel terminal No. 12; replace defective parts.
3. Open winding (12-14) on T7.	3. Check for a-c volts at power panel terminal Nos. 8 and 9 and V27 (5U4G) socket terminal Nos. 4 and 6; replace defective transformer.

B. SYMPTOM:

A-c hum on carrier; audio frequencies distorted.

POSSIBLE CAUSE	PROCEDURE
1. Capacitor C83, C84, or C85 defective.	1. Bridge good capacitors across suspected ones and compare results; replace defective parts. CAUTION: When lower blank panel is removed to get at capacitors, the 1,600-volt terminal of L32 is exposed.
2. Winding shorted on grid bias choke L31.	2. Temporarily disconnect choke and wire in new one and compare; replace defective parts. See CAUTION above.

22. PLATE POWER SUPPLY CIRCUITS, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

No plate voltage indicated on M2 for 1,600-volt or 700-volt supply.

POSSIBLE CAUSE	PROCEDURE
1. Fuses F5 or F6 blown.	1. Inspect fuses and replace if blown.
2. Relay K18 not operated; dirty contacts on relay K17; bias supply trouble; K18 winding open.	2. Check bias voltage at power panel terminal No. 3; burnish contacts of K17; check resistance at contacts of K17; replace defective parts.
3. Burned contacts or adjustment of relay K18; door switch not making contact.	3. Check for 220-v ac at K18 contacts, power panel terminal Nos. 5 and 6 and 6 and 1; shut off a-c power at switch S16 and clean or adjust relay contacts or door switch; check door latches.
4. Defective rectifier tubes.	4. Usually voltage is indicated on M2 if filaments are lighted; replace burned-out tubes.
5. Open windings on choke L32, L33, L34, or L35 or transformer T8.	5. Check for d-c volts at filament bus-bars on T7 terminal Nos. 20 to 23 using high-voltage test cord. Observe caution. Also check resistance at these terminals.
6. Open winding on resistor R106, R107, R108, or shorted winding on R65 or R66.	6. Check resistance of suspected resistors (fig. 20). See that power is off and filter capacitors are discharged before touching any apparatus.

B. SYMPTOM:

Meter M2 indicates less than 650 volts for 700-volt supply under load.

POSSIBLE CAUSE	PROCEDURE
1. Defective V30 or V31 (866A) rectifier tubes.	1. Check that both tubes show approximately equal amount of steady blue glow. A defective tube may flash intermittently; replace suspected tubes and recheck. *Allow 30 minutes heating time for new tubes.* See paragraph 4**b**.
2. Foreign ground on 700-volt lead.	2. Check resistance at audio panel terminal No. 24, driver panel terminal No. 28, and power panel terminal No. 38; isolate panel in trouble if low resistance is indicated. Replace defective apparatus or clear wiring trouble.
3. Defective resistors R108 or R65.	3. Discharge filter capacitors and check suspected resistor. Be sure that d-c meter switch is on p-a space when checking R65.

C. SYMPTOM:

Meter M2 indicates less than 1,400 volts for 1,600-volt supply under load.

POSSIBLE CAUSE	PROCEDURE
1. Defective V28 or V29 rectifier tubes.	1. Check that both tubes show approximately equal amounts of steady blue glow when loaded. Good tubes may flash intermittently when not loaded. Replace suspected tube and recheck. *Allow 30 minutes heating time for new tubes.* See paragraph 4**b**.
2. Foreign ground on 1,600-volt lead.	2. Check resistance at audio panel terminal No. 20 and isolate panel that shows low resistance. Replace defective parts and clear wiring.
3. Defective resistor R66, R106, or R107.	3. Shut off power and discharge 1,600-v filter capacitors and then check suspected resistors. Be sure that d-c meter switch is on P.A. space when checking R66.

23. CRYSTAL OSCILLATOR AND FIRST AMPLIFIER GRID CIRCUITS, TROUBLE-SHOOTING CHART.

The crystal oscillator in this transmitter is capable of driving the following stages even when the oscillator output power is very low. Thus it will function satisfactorily for radiotelephone or two-tone telegraph service when very low values of oscillator grid current are indicated on meter M2. (See pars. 4**f** and 9**b** for additional information.) Trouble in this stage will usually be indicated by a *zero* grid current reading for the oscillator and first amplifier. When this condition is encountered, follow steps outlined.

A. SYMPTOM:

No grid current, oscillator or first amplifier, with test key operated.

POSSIBLE CAUSE	PROCEDURE
1. EMISSION switch S1 set on EXT. OSC. or TWO-TONE.	1. Set switch S1 on PHONE-CW position.
2. BAND switch S5 or S6 and associated OSCILLATOR dial set improperly for crystal frequency.	2. Reset BAND SWITCH and OSCILLATOR dial as shown in paragraph 40, Tuning Chart, or station records.
3. Defective oscillator tube V1 (6J5).	3. Replace V1 with new tube and recheck readings.
4. Defective crystal.	4. Test the crystal in another transmitter known to be OK; if found defective, replace.
5. No oscillator plate voltage; relay K2 not on MARKING contact; defective switch S1B; R15 open; C9 or C15A shorted; dirty contact relay K4.	5. Check operation of relay K2 with TEST KEY; check resistances and voltage for V1 plate (C15A and V1 socket terminal No. 3).
6. Oscillator grid circuit open or grounded.	6. Check resistance at V1 grid (X1 terminal No. 5), crystal sockets X9 and X10 and driver panel terminal No. 17.
7. Band switch S5A or S6A not making contact (bands A and C only).	7. Check for normal operation on bands B or D with another crystal; inspect band switch contacts, wiring and taps on coils L4 and L5 in driver panel; replace defective parts. CAUTION: Use extreme care in removing switch shafts when replacing switch units to prevent damaging the other switch units on that shaft.
8. Defective V5 (6H6); elements shorted or grounded.	8. Set TWO-TONE capacitor at 100 to reduce the effect of a defective V5; replace defective tube.
9. Voltage dropping resistor R19, R21, R23, R24, or R25 open or grounded.	9. Check voltage at each resistor in turn; replace defective parts.

B. SYMPTOM:

No first amplifier grid current; oscillator grid current OK.

POSSIBLE CAUSE	PROCEDURE
1. Defective V2 (802).	1. Observe if V2 cathode is heated; replace with new tube.
2. First amplifier grid circuit open or grounded.	2. Check resistance at X2 (802 socket) terminal No. 4 and driver panel terminal No. 22.
3. Grid blocking capacitor open.	3. Inspect C10 by removing driver unit and shield; bridge suspected capacitor with new one and recheck in transmitter.
4. First amplifier cathode resistor open.	4. Check resistance at X2 (802 socket) terminal Nos. 5 and 6; replace resistor if defective.

24. FIRST AMPLIFIER PLATE AND SECOND AMPLIFIER GRID CIRCUITS, TROUBLE-SHOOTING CHART.

The first amplifier stage amplifies straight through on bands A, B, and C and doubles in its plate circuit on band D. Its screen grid (G2) voltage is keyed simultaneously with the oscillator plate voltage for controlling the r-f carrier. The plate voltage may be varied by means of EXCITATION controls R31 or R32 to compensate for the normal variations of vacuum tubes V2 and V3 (802 and 807) and irregularities of drive in the various bands. The plate voltage is carried through the contacts of relays K7, K8, and K9 which open this circuit to cut off the r-f drive for a short period of time during the transferring of channels. This stage is subject to wide variations of grid drive, especially when two-tone telegraph is used, but is so designed that it will provide adequate drive to the second amplifier under all conditions. Because of variations found in its grid, screen, and plate voltage, it is not possible to establish absolute values of power output, but a second amplifier grid current of 0.8 to 1.5 ma usually indicates normal operation. It may be necessary to increase the second amplifier drive by turning the EXCITATION control clockwise when using two-tone telegraph. This stage should not be considered in trouble unless the following is encountered:

A. SYMPTOM:

No grid current second amplifier; first amplifier grid current normal.

POSSIBLE CAUSE	PROCEDURE
1. FIRST AMPLIFIER dial set improperly for frequency in use.	1. Retune first amplifier dial as shown on tuning chart or station record.
2. Defective first amplifier tube V2 (802); tube gassy or inactive.	2. Replace V2 with new tube and recheck readings.
3. No voltage on V2 screen grid (G2); R18 open or C15B shorted.	3. Check screen grid voltage at C15B or X2 terminal No. 3; replace defective parts.
4. No plate voltage on V2; dirty contact K5, K7, K8, or K9; resistor R31 or R32 open; C19 shorted.	4. Check plate voltage at K7 and V2 plate cap; vary adjustment of R31 or R32; replace defective parts; clean relay contacts.
5. Defective blocking capacitor; C20 open or grounded.	5. Inspect C20 and associated wiring in driver panel shield; bridge C20 with new capacitor and recheck; replace defective parts.
6. Second amplifier grid circuit open or grounded; L9, R20, or R63 open; C21 shorted.	6. Check resistance at X3 (807 socket) terminal Nos. 3 and 4 and driver panel terminal No. 24; replace defective parts.
7. Defective second amplifier tube V3 (807); heater open.	7. Inspect tube for heated cathode; replace defective tube.

B. SYMPTOM:

R-f drive insufficient at second amplifier grid with EXCITATION control in extreme clockwise position.

POSSIBLE CAUSE	PROCEDURE
1. First or second amplifier tubes weak or deactivated.	1. Replace V2 (802) or V3 (807) or both.
2. Partial break-down of resistors or capacitors in first amplifier plate or second amplifier grid circuits.	2. Make voltage and resistance tests at X2 and X3 (all terminals and plate caps) ; replace defective parts.
3. Band switch S5B or S6B not making contact; defective taps on L6 or L7.	3. Compare FIRST AMPLIFIER dial reading with tuning chart or station record; inspect band switches and coils in driver panel; replace defective parts. CAUTION: Use extreme care in removing switch shafts when replacing switch units to prevent damaging other switch units on that shaft.

25. SECOND AMPLIFIER PLATE AND P-A GRID CIRCUITS, TROUBLE-SHOOTING CHART.

The second amplifier stage amplifies straight through on band A and doubles in its plate circuit on bands B, C, and D. Fixed bias is supplied its grid while the plate and screen voltages are automatically adjusted for optimum operation in all bands. The band switches connect the plate tuning circuits to the proper point on the voltage dropping resistors. This connection changes the load on this network and adjusts the plate voltage at the oscillator and first amplifier and screen voltage at the first and second amplifiers as required to provide the necessary drive to the power amplifier. Resistors R29 and R30 are placed across portions of second amplifier plate inductors L10 and L11 to keep the plate load impedance uniform throughout the frequency range. These resistors are shorted out on band D. The fixed bias on the p-a grids is increased to approximately —140 volts when a p-a grid current of 11 ma is flowing. With average tubes the p-a stage will produce normal power output with the grid current between 8 and 15 ma. Grid currents greater than 15 ma may tend to cause a reduction in output power but no steps should be taken to reduce this grid current unless it exceeds 20 ma. Indications of trouble in this stage are listed below:

A. SYMPTOM:

P-a grid current less than 8 ma with power amplifier loaded.

POSSIBLE CAUSE	PROCEDURE
1. SECOND AMPLIFIER dial set improperly.	1. Retune FIRST AMPLIFIER dial as shown on tuning chart or station records.
2. Defective second amplifier tube V3 (807) ; tube gassy or inactive.	2. Replace V3 with new tube and recheck readings.
3. Defective p-a tubes V11 or V12; tubes gassy or inactive; filaments open.	3. Check for heated filaments; blue glow inside tube plates indicates a gassy tube; replace V11 or V12 or both and recheck.

4. No screen voltage on second amplifier; R22 open; C23 shorted.	4. Check resistance at X3 terminal No. 2 and voltage at R22 (or X3 No. 2); replace defective parts.
5. No plate voltage on V3; defective contacts on band switch S5C or S6C; R26 open; dirty contacts relay K6; C26 or C27 shorted.	5. Check voltage at each resistor in turn and resistance at V3 plate cap with band switch in all four positions.
6. Defective contacts on band switch S5C or S6C; defective wiring or taps on L10 and L11.	6. Usually indicated by incorrect tuning; inspect band switch, wiring, and coil. CAUTION: Use extreme care in removing switch shafts when replacing a switch unit to prevent damaging other switch units on the shafts.
7. P-a grid circuit open or grounded; resistor R51, R52, R53, R54, R55, or R64 open; L16 open; C42 grounded; p-a filament center tap or R68 open.	7. Make resistance tests at X11 and X12 terminal Nos. 1, 4, and 7 and p-a panel terminal Nos. 3, 4, and 5.

B. SYMPTOM:

P-a grid current exceeds 20 ma with power amplifier loaded.

POSSIBLE CAUSE	PROCEDURE
1. R29 or R30 open.	1. Check same crystal and p-a coil in other channel and compare; disconnect resistor and measure; replace if defective.
2. Band switch S5C or S6C (resistor side) crossed or shorted.	2. Check resistance at V3 plate for all bands.
3. P-a grid bias too low; shorted, grounded, or open resistor or capacitor in grid circuit.	3. Check voltage and resistance at X11 and X12 (813 sockets) terminal No. 4 and p-a panel terminal Nos. 3, 4, and 5; replace defective parts.

26. POWER AMPLIFIER PLATE AND OUTPUT CIRCUITS, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

R-f output below normal; p-a grid current normal.

POSSIBLE CAUSE	PROCEDURE
1. Pa improperly tuned; wrong p-a coil for frequency in use. See subpar. 4 below.	1. Check tuning chart or station record for proper dial setting and p-a coil; correct as required.
2. Antenna or associated tuning apparatus improperly adjusted or in trouble.	2. Inspect antenna and associated equipment for loose connections or damaged parts; consult station records for tuning adjustments.

3. Antenna coupling coil in L17 or L18 improperly adjusted, open, shorted, or grounded.	3. See paragraph 4c for tuning procedure; disconnect antenna and check antenna coupling coil for continuity and freedom from grounds.
4. Inactive p-a tubes V11 and V12 (813). NOTE: An overload of *only a few seconds* will deactivate the 813 tube filaments. This usually occurs because drive is applied to the grids when the plate circuit is not tuned to resonance (minimum p-a space current).	4. Replace V11 and V12 with new tubes and compare results. NOTE: Some 813 tubes may be restored to normal activity by removing them from the transmitter and applying 15 volts ac or dc to the *filaments only* for *30 seconds* and then 10 volts for 1 hour. All other elements in the tubes must be free from any voltage and ungrounded during the reactivation process.

B. SYMPTOM:

P-a tubes run hot (plates red).

POSSIBLE CAUSE	PROCEDURE
1. Improper tuning of p-a stage.	1. Check tuning chart or station records.
2. Tuning OK but excessive coupling with antenna coils in L17 or L18.	2. Readjust antenna coupling as outlined in paragraph 4c.
3. Antenna circuit shorted or grounded.	3. Inspect antenna and associated tuning apparatus.
4. Loss of grid bias in p-a stage.	4. Check resistance at X11 and X12 (813 tube sockets) terminal No. 4, and voltage at p-a panel terminal Nos. 3, 4, and 5.

C. SYMPTOM:

Arcs form at relay K11 when channels are transferred.

POSSIBLE CAUSE	PROCEDURE
1. Control circuit relay trouble.	1. See paragraphs 13 to 17 and following for control circuit trouble.

27. GENERAL R-F CIRCUIT, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

Transmitter functions satisfactorily in one channel but is dead or has low output in other channel.

POSSIBLE CAUSE	PROCEDURE
1. Antenna circuit improperly tuned for one channel.	1. Inspect antenna circuit and check station records; retune as required.

2. Defective relay K3 to K7 and K11 or dirty contacts on same.

2. Check meter readings to determine stage in trouble and then proceed as outlined in paragraph for that stage. Control circuit trouble is treated in paragraphs 13 to 17 and following.

B. SYMPTOM:

Transmitter functions satisfactorily in one or more bands but is dead or has low output in other bands.

POSSIBLE CAUSE	PROCEDURE
1. Defective contacts on band switch or taps on plate inductors in driver panel.	1. Usually indicated by the circuit in trouble tuning improperly. Locate defective stage and proceed as outlined for that circuit.

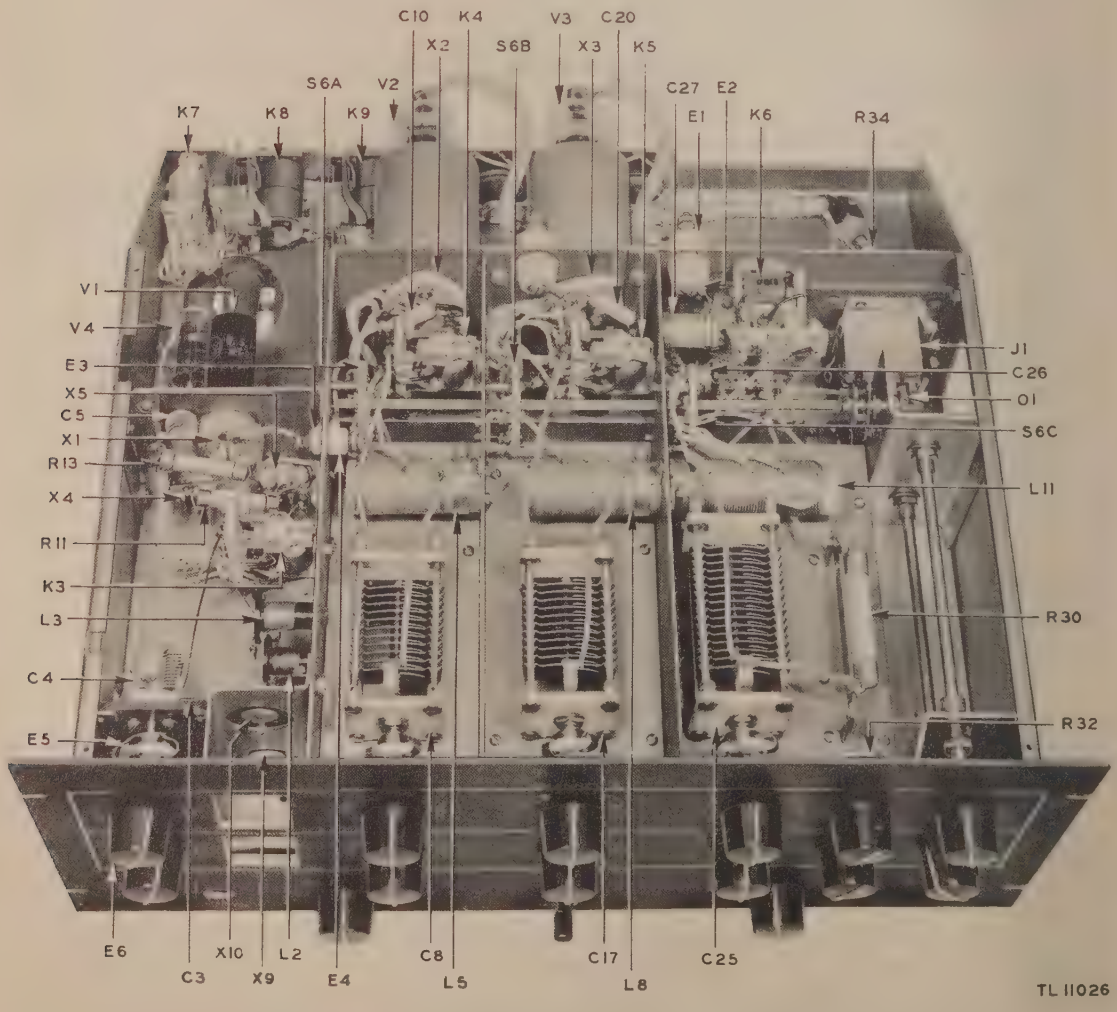


Figure 21. R-f driver panel, top view with cover removed.

C. SYMPTOM:

Spurious oscillations at operating frequency.

POSSIBLE CAUSE	PROCEDURE
1. Open r-f bypass capacitors.	1. Locate stage in trouble by tuning each dial through resonance point until the two controls that maintain oscillations are located. Then shunt a new capacitor across the one suspected. Replace defective parts.
2. Open resistors R29 or R30.	2. Defective R29 or R30 will be indicated by greatly increased p-a grid currents on band A, B, or C.

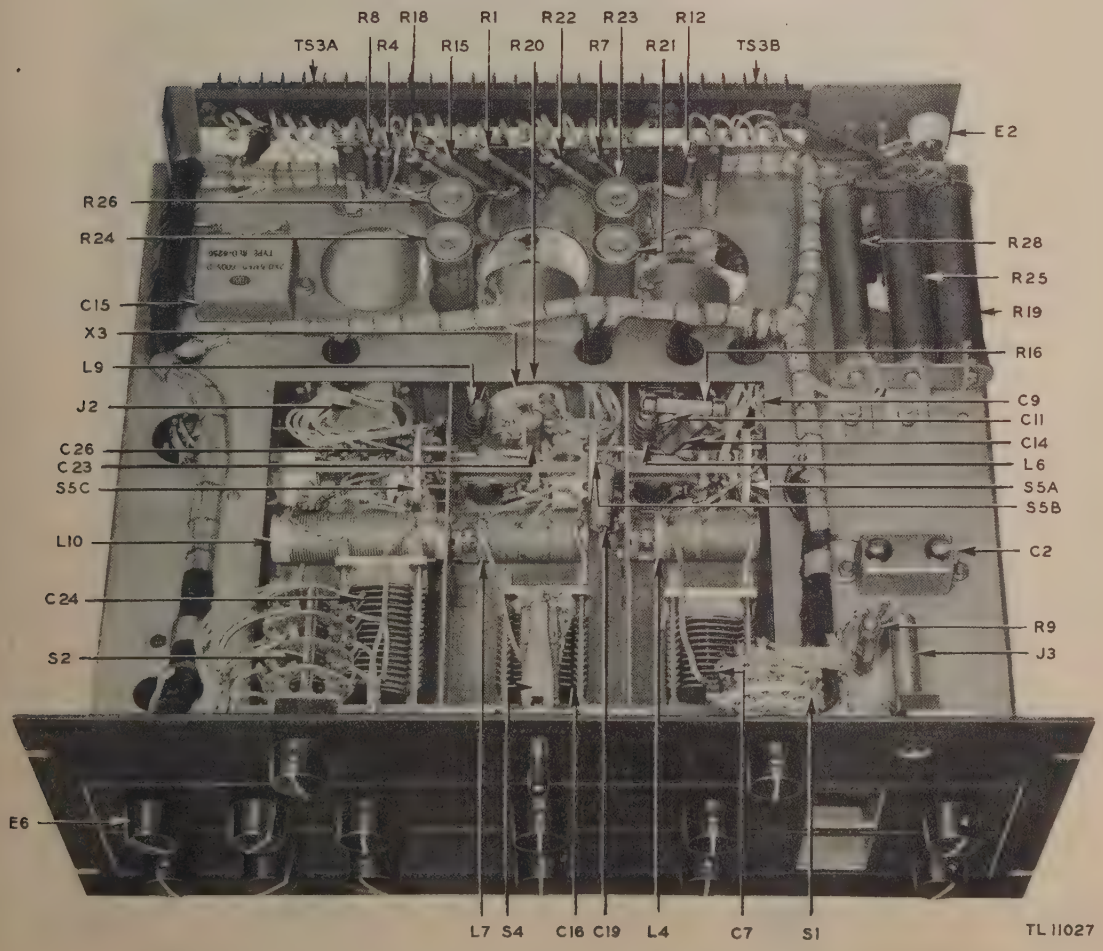


Figure 22. R-f driver panel, bottom view with cover removed.

D. SYMPTOM:

Spurious oscillations at high frequencies.

POSSIBLE CAUSE	PROCEDURE
1. Defective resistors R54 or R55.	1. Check resistance of R54 and R55 at X11 and X12 (813 sockets), terminal Nos. 4 and C41. Replace defective parts.
2. One p-a tube defective.	2. Replace each tube V11 and V12 in turn with a new tube and compare meter readings and power output.
3. Both p-a tubes defective.	3. Replace both tubes V11 and V12 and compare meter readings and power output.

28. TROUBLE SHOOTING AUDIO-FREQUENCY CIRCUITS.

The audio-frequency amplifier consists of three push-pull stages and the associated input and output transformers, filter capacitors, and voltage divider resistors mounted on one chassis. The unit is compact and the terminal side of the tube sockets is not accessible without removing the panel from the

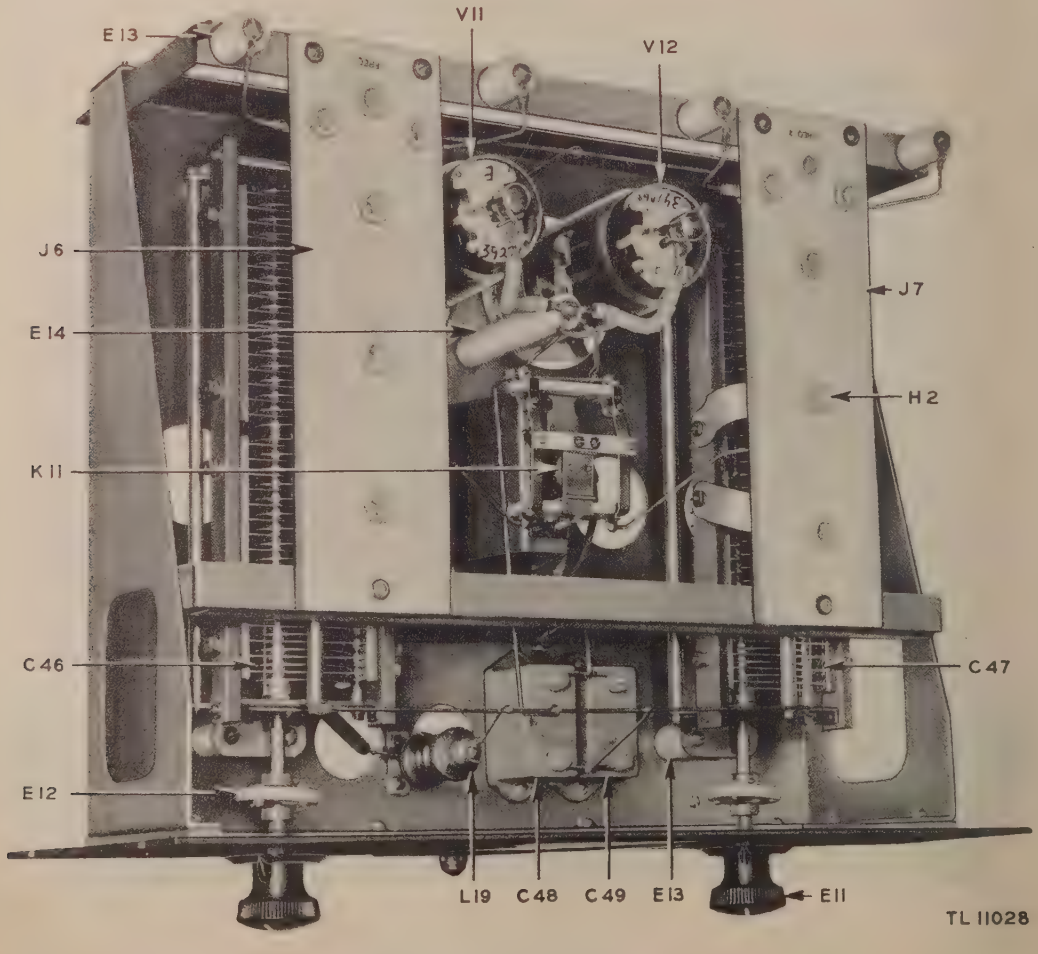


Figure 23. R-f power amplifier panel, top view.

cabinet. This will limit possible trouble shooting when the transmitter is completely assembled, to replacing tubes and making resistance and capacitance tests at the panel terminal strip and tube sockets. If further tests of individual components are required, the panel must be removed from the cabinet and the parts tested on the bench. The trouble conditions listed below cover the major functions of this equipment.

29. AUDIO AMPLIFIER CIRCUIT, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

Audio input does not modulate carrier.

POSSIBLE CAUSE	PROCEDURE
1. Defective tubes; filaments or heaters burned-out; inactive tubes; heater wiring trouble.	1. Check for burned-out heaters or filaments by inspection of V18, V19, and V20 and by feeling shell of 6L7 tubes. Replace suspected tubes and recheck performance.

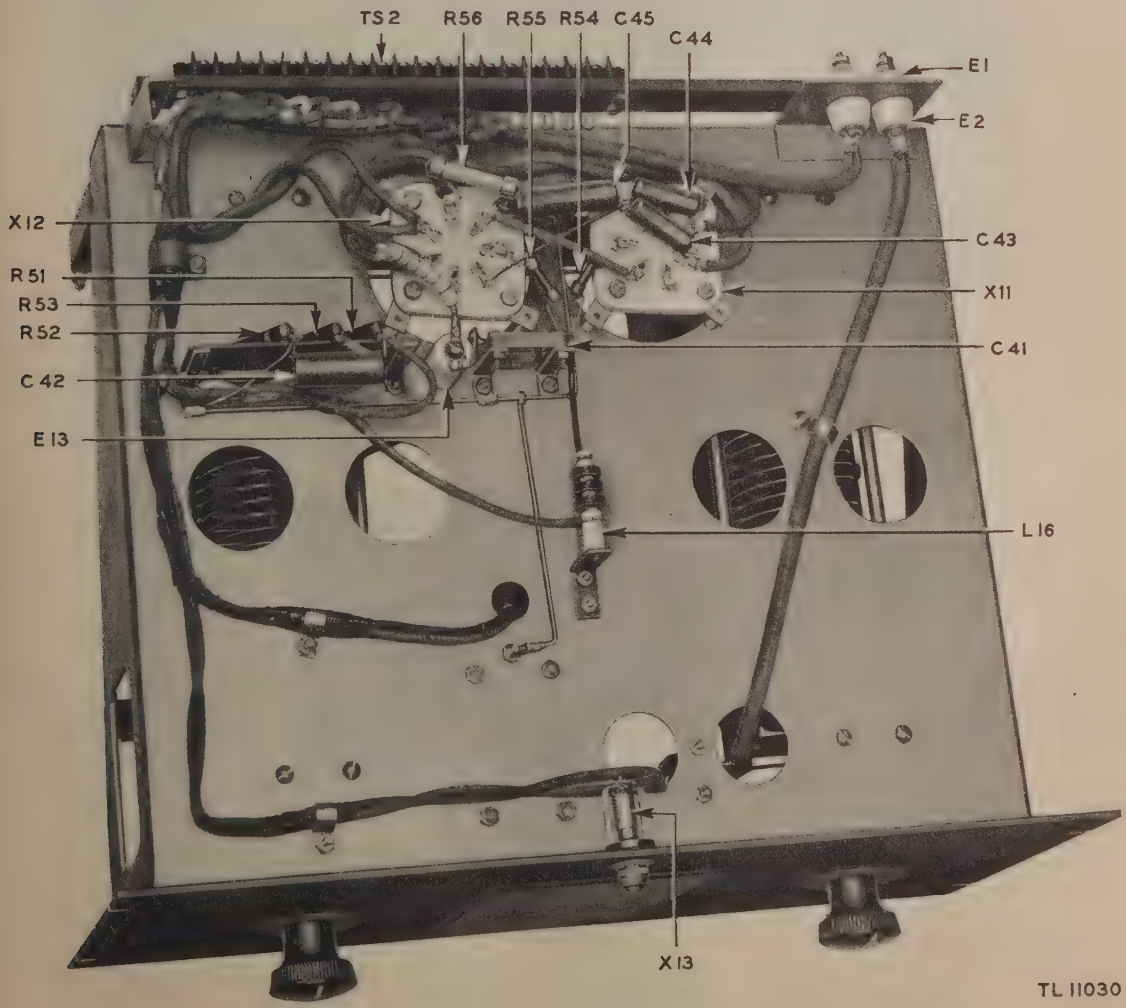


Figure 24. R-f power amplifier panel, bottom view.

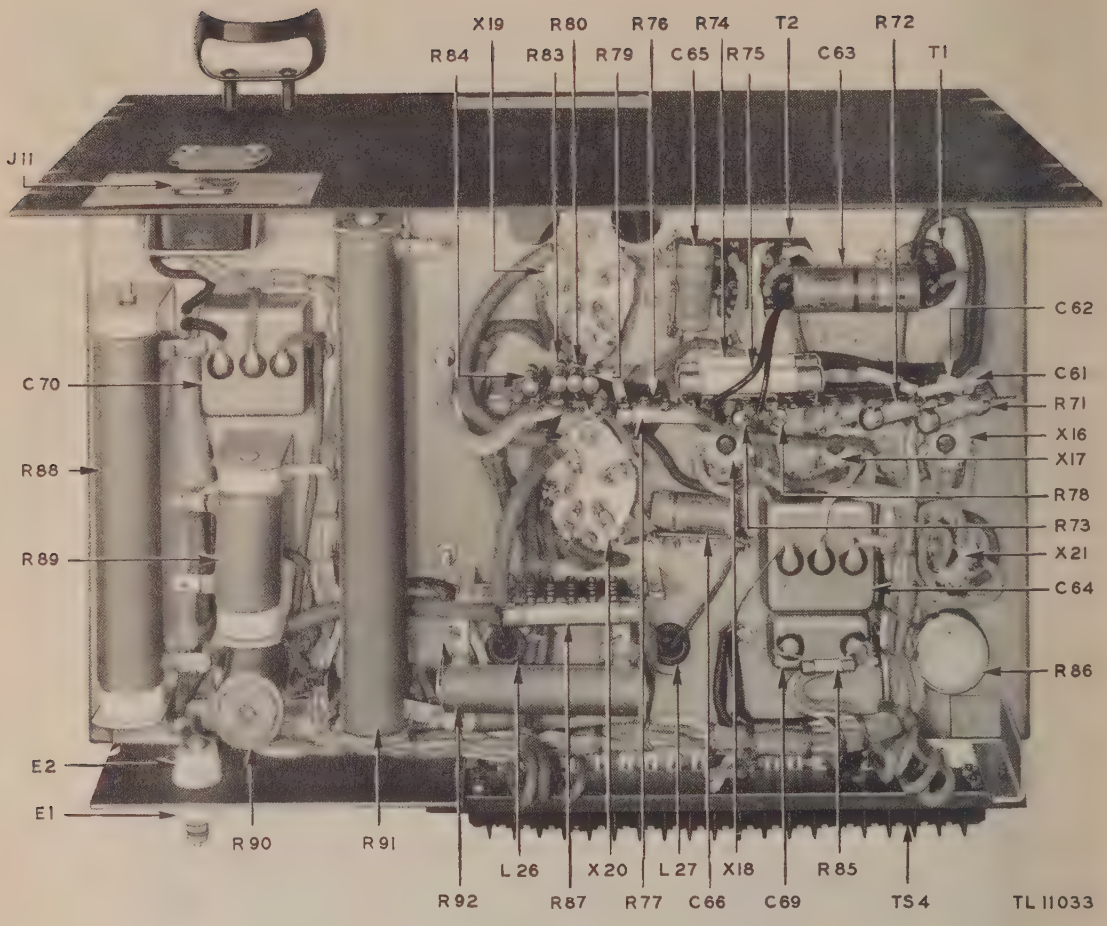


Figure 25. Audio amplifier panel, bottom view.

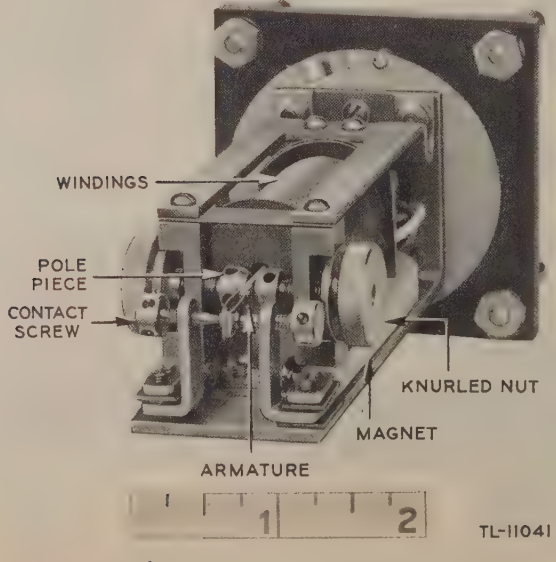


Figure 26. Polar relay K1, K2 with cover removed.

2. Open winding on input transformer T1.	2. Check resistance at V16 and V17 grid (G1) terminals (cap) and audio panel terminal Nos. 1 and 2.
3. Defective contacts on CONTROL switch S2A; reversed or transposed wiring at driver panel terminal strip.	3. Check continuity of leads from audio panel terminal Nos. 1 and 2 to driver panel terminal Nos. 1, 2, 11, and 14 with CONTROL switch S2 in all positions.
4. Defective resistors, capacitors, or transformers in some part of audio amplifier.	4. Have the assistant talk into the microphone or apply tone to speech line; check audio output at each stage in turn. CAUTION: Do not connect a test set or headset directly to any terminal on transformer T3 or plates of V19 or V20 (828's). *Always* use high-voltage capacitors in series with the test leads and be sure to discharge the capacitors after each test.

B. SYMPTOM:

Meter M2 shows only a small increase in modulator space current with speech input when the r-f carrier is ON.

POSSIBLE CAUSE	PROCEDURE
1. Speech input too low; line trouble.	1. Check speech level at line terminals at transmitter with a power level meter or low impedance headset. An average volume level of 30 db below 0.006 w on the line will equal approximately 1.5 volts between grid caps of V16 and V17 measured with a vacuum tube voltmeter.
2. Vacuum tubes V16 to V20 weak or deactivated.	2. Replace tubes one at a time and compare results obtained.
3. Defective resistors or capacitors in voltage divider network.	3. Check voltage and resistance at all socket terminals and caps.
4. Volume limiter control not properly set; volume limiter trouble.	4. Adjust R86 as required. See paragraph 31 on Volume Limiter.

C. SYMPTOM:

Antenna power is decreased with modulation.

POSSIBLE CAUSE	PROCEDURE
1. Leads transposed on transformer T3 terminals 5 and 6 or 3 and 4 or at audio panel terminal No. 6, 20, 21, 22, or 23.	1. Check wiring from audio panel terminals 20, 21, 22, and 23 to T3 (fig. 32); correct as required.
2. Defective transformer T3.	2. Replace transformer and compare.
3. Insufficient r-f drive to p-a stage; defective p-a tubes; antenna circuit not tuned properly.	3. Check operation of p-a stage as outlined under r-f circuits.

D. SYMPTOM:

Audio amplifier "sings" (oscillates).

POSSIBLE CAUSE	PROCEDURE
1. One of the 6L7 tubes burned-out; one section of V18 defective; one of the 828 tubes burned-out; tube elements crossed or grounded.	1. Check filaments and heaters in all tubes; replace each one in turn and recheck.
2. Unbalance due to failure of grid or cathode resistors, transformer T1, T2, or T3, or choke L26 or L27; defective wiring.	2. Make resistance tests at all tube sockets (and caps) starting with V16; replace defective parts or wiring.
3. Failure of bypass capacitors C63, C64, and C70 or feedback capacitors C67 and C68.	3. Bridge suspected unit with a new capacitor until defect is located; replace defective parts.

E. SYMPTOM:

Transformer T3 "sings" with modulation.

POSSIBLE CAUSE	PROCEDURE
1. Loose laminations in transformer; transformer not mounted securely.	1. Check mounting screws. This condition may be disregarded if the mounting is secure and the modulator output is satisfactory. Otherwise replace transformer T3.

30. HANDSET AND MICROPHONE CIRCUIT, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

Handset push button does not turn on carrier.

POSSIBLE CAUSE	PROCEDURE
1. Handset button not making contact; cord open.	1. Check continuity of cord and contacts; replace if defective.
2. Wiring or jack defective.	2. Check voltage and resistance at J11 on front of audio panel; correct as required.

B. SYMPTOM:

Handset microphone does not modulate carrier.

POSSIBLE CAUSE	PROCEDURE
1. Microphone open; wiring trouble; R105 open; R104 shorted or grounded.	1. Check voltage at audio panel terminal No. 3 with handset button both operated and normal, with switch S2 on channel Nos. 1 and 2.

2. Microphone shorted.	2. Check for speech input at audio panel terminal Nos. 1 and 2 from handset microphone when switch S2 is on channel Nos. 1 and 2.

31. VOLUME LIMITER CIRCUIT, TROUBLE-SHOOTING CHART.

A. SYMPTOM:
Volume limiter does not prevent overmodulation.

POSSIBLE CAUSE	PROCEDURE
1. R86 set improperly.	1. See paragraph 4**d** for adjustment of volume limiter control. For speech input at 30 db below 0.006 w, R86 is usually set between 6 and 8 on the dial.
2. Defective tube V21 (6H6).	2. Check that V21 is heated; replace if defective.
3. Winding (1-2) open on transformer T3; C69 or R85 shorted or grounded.	3. Make resistance test at V21 socket; replace defective parts.
4. R86 open at ground end.	4. Check voltage at X21 (6H6) terminal Nos. 4 and 8.

B. SYMPTOM:
Volume limiter prevents complete modulation.

POSSIBLE CAUSE	PROCEDURE
1. R86 set improperly.	1. See paragraph 4**d** and item A1 above.
2. R86 or R87 open.	2. Check voltage at X21 (6H) terminal Nos. 4 and 8.

32. GENERAL AUDIO-FREQUENCY CIRCUITS, TROUBLE-SHOOTING CHART.

SYMPTOM:
Amplifier "motorboats."

POSSIBLE CAUSE	PROCEDURE
1. Loose grid cap on one or more tubes; tubes loose in sockets; defective socket.	1. Check that all tubes are firmly seated in sockets and that grid or plate caps are tight.
2. Defective bypass capacitor C63A, C63B, C64A, C64B, C70A, or C70B.	2. Bridge suspected capacitor with a good one and compare results; replace if defective.
3. Open resistor R71, R72, R83, R84, or R85.	3. Check resistance at sockets X16, X17, X19, X20, and X21.

33. TWO-TONE TELEGRAPH CIRCUITS, TROUBLE-SHOOTING CHART.

As covered in paragraph 4**e**, the operation of relay K1 under control of an external telegraph equipment causes the carrier frequency to shift 850 cycles to provide the necessary *marking* and *spacing* signals. This is accomplished by applying negative or positive voltage on the plates of V5 (6H6) thereby establishing a high or low impedance condition, respectively, in this tube. In the normal or *marking* position of relay K1, the armature is on the *right-hand* contact (No. 4) and —55-volt power is connected through resistors R12 and R11 to V5 plates. This blocks the tube and prevents the rectifi-

cation of r-f feedback from the oscillator grid through variable capacitator C3 or C4. This effectively reduces the capacitance in parallel with the crystal grid circuit to a low value equal to internal capacitance of V5 in series with C3 or C4. When K1 is operated to its *spacing* position, its armature is on the *left-hand* contact (No. 5) and +75-volt power is applied to V5 plates through R12 and R11. This causes a direct current flow of approximately 5 ma from plate-to-cathode in V5 which reduces its impedance to a low value and effectively places the capacitance of C3 or C4 in parallel with the crystal grid circuit. This added capacitance in connection with inductor L2 or L3 causes the crystal to shift its frequency *downward* sufficiently to produce an 850-cycle shift (or spread) in the carrier frequency. C3 and C4 are made variable to provide the proper capacitance for various crystals at different frequencies and to permit adjustments for the proper frequency shift when the r-f stages are doubling or quadrupling the oscillator frequency. Resistor R12 and capacitor C2 function as a wave shaping network to eliminate voltage surges at the oscillator grid circuit. Resistor R11 effectively isolates the r-f portion of the circuit from the d-c portion. Switch S1A opens the two-tone keying circuit to eliminate the possibility of trouble being caused by a false operation of relay K1 when the transmitter is being used for c-w telegraph or radiotelegraph service or when an external oscillator is being used.

A. All crystals which may be satisfactory otherwise for c-w or radiotelephone service in this transmitter may not be satisfactory for two-tone telegraph service. Some crystals do not shift frequency readily. Crystals adjusted to the characteristics of the oscillator should shift frequency readily.

B. In an emergency it may be possible to obtain a serviceable two-tone telegraph circuit when using a crystal which will not shift frequency far enough to obtain the full carrier frequency shift (or spread) of 850 cycles. *In this case only,* the radio circuit may be lined up by adjusting the TWO-TONE dials (C3 or C4) for the *maximum frequency shift* (or spread) which will give *constant carrier output* and then transmitting "polar dots" (miscellaneous signals) from the telegraph terminal. The receiving terminal should be aligned to center on the transmitted frequencies. *This scheme should only be used in an emergency* as the margins allowed for crystal frequency drift and other circuit variations are reduced accordingly.

C. SYMPTOM:

Oscillator frequency cannot be shifted from remote telegraph station.

POSSIBLE CAUSE	PROCEDURE
1. Two-tone line loop open or grounded; winding open on relay K1.	1. Check line currents for *mark* and *space* signals.
2. Relay K1 armature sticking on one contact; foreign matter between armature and pole piece; relay adjustment.	2. Observe relay and clean contacts and pole pieces or adjust as outlined in paragraph 39.
3. Vacuum tube V5 (6H6) burned-out; resistor R11 or R12 open; capacitor C2 shorted or grounded; defective contact on switch S1A.	3. Make resistance and voltage tests at V5 (6H6) and jack J1; try a new tube at V5 (6H6); replace defective parts.
4. Dirty contacts on relay K3; relay K3 adjustment.	4. Inspect relay and clean or readjust as outlined in paragraph 39.

D. SYMPTOM:

Carrier frequency shift is more or less than 850 cycles.

POSSIBLE CAUSE	PROCEDURE
1. TWO-TONE dial set improperly.	1. Reset C3 or C4 dials as required to correct frequency shift.

E. SYMPTOM:

Maximum carrier frequency shift obtainable with constant carrier output is less than 850 cycles.

POSSIBLE CAUSE	PROCEDURE
1. Crystal in use is wrong type for two-tone telegraph service; crystal is cracked or has low activity for other reasons.	1. Replace crystal unit and recheck. See subparagraph **B** above.
2. Inactive V1 or V5 (6J6 or 6H6).	2. Replace tubes one at a time; compare results.
3. Trouble in r-f amplifier stages; setting of EXCITATION control; inactive V2 or V3 tubes.	3. Check operation of r-f stages while two-tone station is sending a *marking* signal; replace suspected tubes and compare results.

F. SYMPTOM:

Oscillator stops oscillating when switch S1 is set on TWO-TONE or when spacing signal is sent.

POSSIBLE CAUSE	PROCEDURE
1. TWO-TONE dials set too low (C3 or C4 capacitance too high).	1. Readjust TWO-TONE dials as required.
2. C3 or C4 plates shorted.	2. Inspect capacitors and readjust plates or replace defective parts.
3. Defective crystal.	3. Replace unit.

G. SYMPTOM:

Signals show excessive *marking* bias.

POSSIBLE CAUSE	PROCEDURE
1. Frequency drift at transmitter or receiver; misalignment of radio circuits.	1. Realign transmitter as covered in paragraph 4**e**.
2. Resistor R4 open.	2. Check resistance at driver panel terminal No. 25 (all tests) ; check voltage at jack J1, terminal No. 3, and C2.

3. Contacts sticking on relay K1; foreign matter between armature and pole pieces.	3. Inspect relay K1; clean and adjust as required. See paragraph 39.

H. SYMPTOM:

Signals show excessive *spacing* bias.

POSSIBLE CAUSE	PROCEDURE
1. Frequency drift at transmitter or receiver.	1. Realign transmitter as covered in paragraph 4e.
2. Defective V4 (OA3/VR75-30); resistor R8 open.	2. Check voltage at C2 and jack J1 terminal Nos. 4 and 5; check V4 for blue glow (ionization); replace defective parts.

34. EXTERNAL OSCILLATOR CIRCUIT, TROUBLE-SHOOTING CHART.

A. SYMPTOM:

R-f input insufficient to drive transmitter.

POSSIBLE CAUSE	PROCEDURE
1. Power output of external oscillator below requirements.	1. See paragraph 1i for power requirements.
2. Output impedance of external oscillator does not match input impedance of transmitter circuit.	2. See paragraph 1i for impedance matching requirements.
3. Resistor R9 shorted or grounded; switch S1B defective; C11 open.	3. Check resistance at J3 tip contact; inspect S1B and C11.

B. SYMPTOM:

Transmitter does not key properly using the external oscillator.

POSSIBLE CAUSE	PROCEDURE
1. Input r-f voltage too high or too low.	1. Compare first amplifier grid current with that obtained using the crystal oscillator. Adjust power output of external oscillator.

C. SYMPTOM:

Oscillator grid current indicated on M2 when using an external oscillator.

POSSIBLE CAUSE	PROCEDURE
1. Switch S1B not making contact; wiring trouble.	1. Check resistance at driver panel terminal No. 16 with S1B in EXT. OSC. position.

35. VOLTAGE MEASUREMENTS.

a. General. Various points at which voltages may be measured are shown on figures 39, 40, 41, and 42. The voltage test points required for clearing trouble are shown in detail. Other points may be tested if necessary. The voltages shown are actual *operating voltages* with the transmitter operating at full power output except where it is necessary to turn off part of the power supplies to make certain terminals available. Since most of the voltage measurements require the high-voltage power supply to be ON, locate the test meter outside of the transmitter cabinet and connect it to the test points with well-insulated leads which may be run through the vent holes in the rear door. Voltages are shown as measured between the test points and the transmitter ground or chassis framework except for voltages (such as the 220-v a-c line) which are normally ungrounded. In those cases voltages are shown as measured between two test points.

(1) *Remember that the voltages shown are the average of many transmitters and are subject to variation due to commercial variations of tubes, resistors, capacitors, transformers.* Do not replace any apparatus suspected of causing a voltage variation if that apparatus is within its individual tolerance limits. Variations from the voltages shown may be the cumulative result of several pieces of apparatus having variations all of which are within their individual tolerance limits.

(2) All voltage measurements are made with an analyzer and the associated high-voltage test cord and adapter plugs which are part of Test Set I-56-A. All readings are taken with the meter set for the scale next higher above the voltage read except where specific meter scales are listed. If some other test set is used, the meter resistance may have some bearing on the voltage indicated.

> **CAUTION:** Make one test connection at a time. Keep one hand in your pocket. The voltages in this transmitter are lethal. Take time to be careful and live. There is plenty of time to be dead.

b. Driver Panel Voltages (fig. 39). The tube socket terminals in the driver panel are not readily accessible when the transmitter is operating, so alternate test points have been shown at the various resistors to which the tube elements are connected. This increases the accuracy of voltage measurements since the r-f voltages at the tube elements do not influence the readings. It is well to note that different voltages are indicated for each tube element for different positions of band switches S5 and S6. These voltages represent an average of each band when sending either a *mark* or *space* signal on two-tone telegraph. Similar voltage readings should be obtained when using radiotelephone or c-w telegraph.

c. Radio-frequency Power Amplifier Voltages (fig. 40). The plug-in coils L17 and L18 have been omitted from figure 40 for the sake of clarity; both of these coils must be in place when the transmitter is in operation. The only difficult point to reach when measuring voltages on this panel is the cotter pin terminal at the mounting end of the grid choke L16. Care should be used when connecting a test clip at this point to prevent damaging the small wire from the winding of L16 which also terminates at this point.

> **CAUTION:** There will be —110 volts on this terminal when the filaments are lighted. The voltage at V11 and V12 (813's) plate caps should not be measured while the r-f carrier is on. Use caution. A high-voltage or r-f burn takes months to heal.

d. Audio-frequency Amplifier Voltages (fig. 41). The inaccessibility of the wiring side of the tube sockets in the audio panel necessitates the use of the analyzer plugs in Test Set I-56-A when checking tube element voltages. The tube should be placed in the adapter socket when the voltage is being checked. Use extreme caution when checking voltage at V19 and V20 (828) sockets. There will be 700 volts on the screen grids (G2) and 1,600 volts on the plates of V19 and V20. Play it safe.

e. Power Panel Voltages (fig. 42). Extreme caution should be observed when checking any voltage on the power panel. The test points which require the meter to be returned to another test point should be followed carefully. *Discharge the high-voltage*

filter capacitors with an insulated-handle screwdriver before touching any part of the transmitter after plate voltage has been on.

36. RESISTANCE MEASUREMENTS.

a. General. Various test points where resistance measurements may be made readily are shown on figures 43, 44, 45, and 46. All power should be shut off by turning switch S16 off and allowing tube cathodes to cool before making any resistance tests. The only exceptions to this are the tests at tube plate circuits in the driver panel which require the operation of channel switching relays.

(1) All resistance tests are made with the analyzer which is part of Test Set I-56-A. The range used should be the one which gives a reading near midscale if possible. Carefully adjust the ohmmeter for zero reading each time it is used and whenever the range is changed. All wiring and tubes remain in place unless otherwise noted.

(2) Resistance tests are made between the test points and ground unless otherwise specified in notes or charts. One or more pieces of apparatus may be included in the circuit being tested. Tests have been arranged to include all apparatus in some test if possible. Positions of the various switches are specified to test the continuity of their contacts wherever possible. Some test points have two or more resistance values given. The explanatory notes usually indicate that the additional resistance values are obtained when the terminals of common leads (such as the —110-v bias supply) are disconnected at the terminal strip. This will permit isolating trouble in circuits having parallel resistors in two or more panels.

(3) The —110-volt bias supply has polarized electrolytic capacitors in its circuit which show low resistance readings if the leads to the ohmmeter are poled incorrectly. Try reversing the test leads where noted on resistance drawings and take highest reading obtained.

(4) The +30-volt relay power supply contains polarized electrolytic capacitors and copper-oxide rectifiers all of which may show wide variations of resistance to ground. All tests of the resistance of relay circuits are made with the ohmmeter return connected to the +30-volt terminal instead of ground.

(5) The resistance at filament and heater terminals of tube sockets may show a value too low to read. Test these circuits for voltage if they are in question.

(6) The infinity symbol (∞) is used throughout to indicate resistance values above 2 megohms (meg) or open circuits.

(7) The resistance values shown on figures 43 to 46 are nominal or rated values. Each individual piece of apparatus is subject to commercial variations within the limits shown in paragraphs 46 to 52, Maintenance Parts List. *No part should be replaced if its resistance is within its tolerance limits.* A variation from resistance values shown may be due to the cumulative variations of several parts, all of which may be within their individual tolerance limits.

(8) Inasmuch as relays K1 and K2 may be resting on either contact and cause incorrect resistance reading at many points, *all resistance tests are made with relays* K1 *and* K2 *removed from jacks* J1 *and* J2 *unless otherwise specified.*

b. Driver Panel Resistance Diagram (fig. 43). All resistance tests on driver panel are made at accessible points such as tube sockets, relay jacks, and terminal strips. Use care in setting switches and locating test meter return points as specified, when making all tests. All tubes remain in their sockets except when testing the terminals of a socket, after which the tube should be replaced.

c. R-f Power Amplifier Resistance Diagram (fig. 44). All resistance tests are made at accessible points such as tube sockets, terminal strips, and capacitor frames.

> **CAUTION:** Discharge filter capacitors in high-voltage power supply before touching any apparatus. Do not depend on R106 and R107 to discharge these capacitors. The resistors may be open.

d. Audio Amplifier Resistance Diagram (fig. 45). All resistance tests are made at accessible points such as tube sockets, terminal strips. If the resistance of individual parts is to be checked, it may be more practical to remove the panel to a bench for testing. See CAUTION under subparagraph (3) above.

e. Power Panel Resistance Diagram (fig. 46). Observe care in making resistance tests on this panel and do not contact terminals 13 or 14 or any 220-v leads. Follow figure 46 closely to make meter returns to proper points. It will be necessary to make additional tests on the individual pieces of apparatus if items such as transformers or chokes are in trouble.

37. FAN AND FILTER UNIT.

a. Fan Motor. The fan motor is equipped with sealed ball bearings which require no lubrication. The motor must be fastened tightly in its mounting. The screen protector should be left in place over the blades of the fan.

b. Air Filter. The spun glass air filter must be replaced occasionally. Its life depends on the hours of use and the amount of dust in the air. The condition of the filter should be observed periodically. The filter may be vacuum cleaned from the outside while it is mounted in the door of the transmitter. If a vacuum cleaner is not available, remove the filter from its frame and clean by rapping it several times with the intake side in the down position. Replace the filter if there is a noticeable reduction in the volume of air through the filter. Once the life of the filter in any particular installation has been determined, a replacement routine should be followed. Install a new filter with the arrows printed on the nameplate pointing in the direction of the air flow into the transmitter.

38. FUSE PROTECTION.

a. Location. Six plug-type fuses are located on the rear of the power panel adjacent to terminal strip TS5 as shown in figures 4 and 18. Two of these fuses are in the 220-volt a-c line, two in the plate power transformer primary circuit, one in one side of the fan circuit, and one in the relay power transformer circuit. The circuit, rating, function, and designation of all six fuses are engraved on a nameplate located centrally on the fuse cut-out blocks.

b. Function. (1) Fuses F1 and F2, rated at 15 amperes, serve as main line fuses in the 220-volt a-c leads to the transmitter. They are wired into the circuit on the equipment side of switch S16, one in each side of the line. They serve to protect the entire transmitter from a-c line voltage surges and to open the line in case of an overload caused by a short circuit or other trouble in filament and bias transformer T7 or associated wiring.

(2) Fuse F3, rated at 1 ampere, serves to protect the +30-volt supply from a-c line voltage surges and to open the primary circuit of T6 in event of a short circuit in rectifier COR1 or COR2.

(3) Fuse F4, rated at 2 amperes, protects the fan from a-c line voltage surges and opens the line in event of a winding failure in fan.

(4) Fuses F5 and F6, rated at 10 amperes, protect plate transformer T8 from a-c line voltage surges and open the primary circuit in event of an overload on the plate power supply. Fuse F6 is also in the fan circuit.

c. Cause of Failure. (1) Failure of fuses F1 and F2 usually indicates trouble in transformer T7 and its associated wiring and apparatus, or excessive a-c line voltage. Fuse F1 may also blow if the primary of transformer T6 becomes grounded.

(2) Failure of fuse F3 usually indicates a short circuit in rectifier COR1 or COR2 or a short or ground in transformer T6.

(3) Failure of fuse F4 usually indicates a defective fan motor.

(4) Failure of fuses F5 and F6 usually indicates an overload on transformer T8 or the plate power supply. This may be caused by any one of the following:

(*a*) Rectifier tubes flashing over. This is usually found only in tubes that have been used for a long time.

(*b*) High-voltage filter capacitor failure.

(*c*) Vacuum tube failure in r-f p-a (813) or audio p-a (828) stages.

(*d*) Momentary overload due to improper tuning of r-f p-a stage during tune up.

(*e*) Flashover at audio or p-a panels because of applying modulation to the r-f p-a stage before it is loaded. May also be caused by loss of r-f load due to antenna circuit failure.

(*f*) Spurious oscillations in r-f or audio power amplifier stages.

(*g*) Insulation failure in transformer T8, wiring, or insulators in high-voltage leads.

39. RELAY MAINTENANCE.

a. Polar Relay K1, K2.

CAUTION: Adjustment of polar relays should be undertaken only by personnel experienced in making adjustments of this type of apparatus.

(1) When Test Set I-193-A is available, perform all adjustments on relays K1 and K2 in accordance with the requirements of this test set, particularly if the transmitter is to be used for two-tone telegraph transmission or if the remote control equipment is located at some distance from the transmitter. If the transmitter is to be used solely for hand keying on c-w transmission and the remote control equipment is near the transmitter, the procedures which follow should result in satisfactory operation of these relays.

(2) The following tools (also furnished with Test Set I-193-A), or their equivalent, are required for cleaning and adjusting the polar relays:

1 Burnishing tool
1 File
1 Tool 340
1 Gauge 74D

(3) Refer to figure 26 which identifies the contacts, adjusting screws, and pole pieces of the polar relay. If, on inspection, the contacts are found dirty, they may be cleaned by burnishing. If the contacts are pitted, they may be reconditioned by *light* filing, followed by burnishing. To do this, back off the contact screw on the pitted side to permit the file to enter between the contact and armature. To prevent the contact springs from bending, insert a toothpick in a central position between the springs, taking care not to insert it far enough to separate the springs. File the contact only to a smooth surface, being careful to remove as little as possible of the contact material. After filing the contact, burnish it. In the final operation clean the burnisher with a lintless cloth moistened with chemically pure carbon tetrachloride. Never use fire extinguisher and cleaning fluids.

(4) If cleaning the pole piece surfaces is necessary, loosen the knurled nuts and back off the pole piece screws as far as they will go with the 340 tool. Remove any foreign material which may be adhering to the pole pieces with a thin piece of brass or other nonmagnetic material (do not use burnisher) covered with friction tape by pressing it against the pole piece surface. Use tape only once and do not rub the pole pieces with the friction tape. Should any sticky substance from the tape become deposited on the pole piece, remove it with a clean lintless cloth moistened with carbon tetrachloride.

(5) Steps in adjusting a relay without the use of Test Set I-193-A, are outlined below:

(*a*) Loosen the knurled nuts and back off the pole piece screws with the 340 tool as far as they will go. Back off the contact screws with the same tool until the armature does not touch either contact.

(*b*) Hold the relay horizontal as shown in figure 26 and advance both contact screws until they just touch the armature.

(*c*) Back off each contact screw one-twelfth turn, or one-third the angle between adjacent holes in the contact screws. One-twelfth of a turn of the contact screw corresponds to 0.002 inches. The armature should then be equidistant between the two contact points and the total armature travel should be 0.004 inches.

(*d*) Advance the right-hand pole piece screw with the 340 tool until the pole piece is near the armature. Then tighten the knurled tension nut on the outside end of the pole piece screw with the fingers only until a noticeable increase in force on the 340 tool is required to turn the pole piece screw. Continue to advance the right-hand pole piece screw with the 340 tool disregarding the magnetic attraction, until the pole piece touches the armature and pushes to the *left* until the armature contact just touches the *left-hand* contact screw. Then back off the right-hand pole piece screw more than one-quarter and less than one-half turn. This establishes a basic point from which other adjustments are made.

(*e*) Advance the left-hand pole piece screw until the pole piece is near the armature, then tighten the tension nut on the left-hand pole piece screw. Advance or retract the left-hand pole piece screw until the armature just sticks to each contact when moved there by hand. If this adjustment cannot be made, advance the right-hand pole piece screw one-eighth turn then again advance or

retract the left-hand pole piece screw to meet the adjustment requirement.

(*f*) Hold the relay horizontal with the armature pointing forward. Roll the relay gradually from one side to the other. The armature should leave the upper contact and fall to the lower contact under the force of gravity if tilted to either side.

(*g*) If the armature does not fall from one contact to the other while tilted from its normal position to its side, back off the pole piece screw a very slight amount at a time on the side where the armature tends to stick. Again check the relay in its normal position to make sure that the armature sticks in either position when placed there by hand.

b. Channel Switching Relays K3 to K7, Inclusive. These relays will not ordinarily require any maintenance other than occasional cleaning of their contacts with a contact burnisher or file. If it becomes necessary to readjust any one of these relays, first give it a visual inspection. Gauge by eye to see that both armature contacts make or break at the same time. It is not necessary that the armature rest against the back stop in an unoperated position, since the full tension of the retractile spring may be taken up by the back contact pressure. The following requirements apply:

Contact gap, 0.015 inch.

Magnetic air gap (between top of freeze pin and core), 0.025 inch.

Contact pressure with the relay in the operated position, 40 grams.

Contact pressure with the relay in the unoperated position, 40 grams.

Minimum operating voltage, 10 volts.

c. Fast Operate—Slow Release Relays, K8 and K9. The contacts of these relays should be cleaned occasionally using a burnisher or file. The slow release of these relays may be observed while changing the CONTROL switch from one channel position to the other. Relay K9 will be somewhat slower in release, however, since the voltage applied across its winding in the channel 1 condition is somewhat greater than the voltage applied across relay K8 in the channel 2 condition. Requirements for these relays are as follows:

Contact gap, 0.015 inch.

Magnetic air gap, 0.012 inch (between top of freeze pin and core).

Nonoperate current, 0.013 ampere.

Operate current, 0.015 ampere.

After operation on 0.054 ampere, the minimum time of release should not be less than one-tenth second. The normal back contact pressure of relays adjusted to meet these requirements is approximately 20 grams.

d. Channel Switching Relay K11. It is important that this relay have a wide contact gap clearance and that both movable members make and break their contacts simultaneously. Take care to keep the isolantite parts clean. If readjusted, this relay should meet the following requirements:

Contact gap, 0.125 inch.

Contact pressure with the relay in the operated position, 40 grams.

Contact pressure with the relay in the unoperated position, 40 grams.

Minimum operating voltage, 22 volts.

e. Power Relays, K16 and K18. These contactor relays do not ordinarily require maintenance other than the occasional cleaning of the contacts with a file. If necessary, the retractile tension may be adjusted to give positive operation with the d-c voltage applied under normal operating conditions of the transmitter.

f. Time Delay Relay K17. Inspect the time delay relay occasionally, and burnish its contacts as necessary. If necessary, readjust the relay to meet the following requirements:

Contact gap, 0.010 inch.

Magnetic air gap, 0.025 inch.

Contact pressure with the relay in the operated position, 15 grams.

Minimum operating voltage, 11 volts.

SECTION V

SUPPLEMENTARY DATA

40. TUNING CHART.

CAUTION: Excessive plate current in the 813 tubes will result in short tube life and may seriously damage the tubes within a few minutes. In tuning the set be careful to avoid this condition by frequent checking of the power amplifier space current. It should not exceed 355 milliamperes. The plates of these tubes should not become red when operating properly in this transmitter.

TUNING CHART

ADJUST OUTPUT COUPLING FOR P. A. SPACE CURRENT OF 355 M. A. MAX.
ADJUST EXCITATION CONTROL FOR 2ND AMP. GRID CURRENT OF 1-1.5 M. A.
ADJUST TWO TONE CONTROL FOR CARRIER SHIFT OF 850~.

CARRIER FREQUENCY	CRYSTAL FREQUENCY	P. A. COIL	BAND SWITCH	TUNING ADJUSTMENT				
				TWO TONE	OSC.	1ST AMP.	2ND AMP.	P. A.
3.00	3.00	9T	A	60	25	20	20	20
3.50	3.50			60	55	50	50	50
4.00	4.00			60	80	75	75	65
4.50	4.50			60	90	90	90	75
4.50	2.25	9T	B	60	25	25	40	75
5.00	2.50	9T		60	50	50	60	85
5.50	2.75	5T		60	65	65	75	45
6.00	3.00	5T		60	80	80	90	55
6.00	3.00	5T	C	60	25	20	15	55
7.00	3.50			60	55	50	50	70
8.00	4.00			60	80	75	75	85
9.00	4.50			60	90	90	90	90
9.00	2.25	4T	D	60	25	30	25	30
10.00	2.50			60	50	55	45	50
12.00	3.00			60	80	80	80	75
13.00	3.25			60	90	90	90	85

41. APPROXIMATE SETTINGS OF TWO-TONE CAPACITOR DIAL.

Crystal frequency (kc)	*Band A*		*Band B*		*Band C*		*Band D*	
	Carrier (f-mc)	*Dial*	*Carrier (f-mc)*	*Dial*	*Carrier (f-mc)*	*Dial*	*Carrier (f-mc)*	*Dial*
2,250			4.5	50			9.0	75
2,500			5.0	53			10.0	76
2,750			5.5	56			11.0	77
3,000	3.0	20	6.0	60	6.0	60	12.0	78
3,250	3.25	25			6.5	62	13.0	80
3,500	3.5	30			7.0	65		
4,000	4.0	40			8.0	68		
4,500	4.5	50			9.0	70		

42. TYPICAL METER READINGS.

Freq band	*Crystal freq (kc)*	*Output freq (mc)*	*Osc grid current (ma)*	*1st amplr grid current (ma)*	*2d amplr grid current (ma)*	*P-A grid current (ma)*	*P-A space current (ma)*	*Line volts (a-c)*	*700-volt rect*	*1,600-volt rect*
A	3,000	3.0	0.3	0.4	1.0	11.0	345	220	700	1,600
A	4,500	4.5	0.4	0.4	1.5	11.0	345	220	700	1,600
B	2,250	4.5	0.3	0.7	1.5	11.0	345	220	700	1,600
B	3,000	6.0	0.4	0.9	1.5	11.0	345	220	700	1,600
C	3,000	6.0	0.4	0.5	1.0	11.0	345	220	700	1,600
C	4,500	9.0	0.5	0.6	1.5	11.0	345	220	700	1,600
D	2,250	9.0	0.5	0.7	1.0	11.0	345	220	700	1,600
D	3,250	13.0	0.7	0.8	2.0	11.0	345	220	700	1,600

43. TYPICAL TEST VOLTAGE DATA (with LINE VOLTS meter reading 220 volts and fuses F5 and F6 removed).

Description or condition of circuit measured	*Panel and terminal Nos.*	*Nominal voltage*
Supply to time delay circuit	Power panel 2–18	100 v ac
Bias rectifier filament	Power panel 16–17	5.2 v ac
700-v rectifier filaments	Power panel 34–35	2.6 v ac
1,600-v rectifier filaments	Power panel 36–37	2.6 v ac
Audio amplifier filaments	Audio amplifier 9–10	6.5 v ac
Audio amplifier filaments	Audio amplifier 18–19	10.2 v ac
R–f driver filaments	R–f driver panel 18–19	6.4 v ac
R–f power amplifier filaments	R–f power amplifier panel 1–2	10.0 v ac
Relay power supply:		
CONTROL sw on OFF	Power panel 19 or 20 to gnd	*40 v dc
CONTROL sw on CHANNEL 1	R–f driver panel 20 to gnd	*35 v dc
CONTROL sw on CHANNEL 2	R–f power amplifier panel 6 to gnd	*25 v dc
Bias voltage	Power panel 3 to gnd; audio amplifier 17 to gnd; r–f driver 25 to gnd; r–f power amplifier 5 to gnd	110 v dc

* Relay power supply d-c voltage varies directly with the primary a-c supply voltage. The values given are for a primary supply of 220 volts or when the LINE VOLTS meter reads 220 and the VOLTAGE switch is on position 4. For other positions of the VOLTAGE switch with LINE VOLTS meter reading of 220, make the following corrections:

Setting of VOLTAGE switch	*LINE VOLTS reading*	*Primary voltage will be*	*Correction to relay supply voltage*
1	220	250	+15%
2	220	240	+10%
3	220	230	+ 5%
4	220	220	0%
5	220	210	− 5%
6	220	200	−10%

44. TYPICAL LINE CURRENTS FOR REMOTE CONTROL RELAYS (with CONTROL switch at transmitter in the REMOTE position and channel switch at remote point in the channel 2 position).

Position of VOLTAGE switch with LINE VOLTS meter reading 220 v	*Relay operating currents (ma)*		
	Power supply K16	*Channel selection K7*	*Carrier control K2*
1	115	145	25
2	110	140	24
3	105	135	23
4	100	130	22
5	95	125	21
6	90	120	20

Normal operating current for polar telegraph relay K1 should be approximately 20 milliamperes.

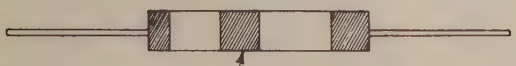
RMA COLOR CODE FOR RESISTORS
(OHMS)

COLOR	A IST DIGIT	B 2ND DIGIT	C MULTIPLIER
SILVER			0.01
GOLD			0.1
BLACK		0	1.0
BROWN	1	1	10
RED	2	2	100
ORANGE	3	3	1,000
YELLOW	4	4	10,000
GREEN	5	5	100,000
BLUE	6	6	1,000,000
PURPLE	7	7	10,000,000
GRAY	8	8	100,000,000
WHITE	9	9	

D - TOLERANCE CODE:

GOLD = 5% SILVER = 10% NO COLOR = 20%

D A C A B



BAND OR DOT

OLD COLOR ARRANGEMENT

A B C D

BODY COLOR

NEW COLOR ARRANGEMENT

EXAMPLE: A-GREEN, B-BLACK, C-ORANGE AND D-SILVER = 50,000 OHMS ± 10%

BODY COLOR (NEW COLOR ARRANGEMENT ONLY) INDICATES TYPE OF RESISTOR, AS FOLLOWS:-
BLACK - COMPOSITION, NONINSULATED
TAN, OLIVE OR WHITE - COMPOSITION, INSULATED
DARK BROWN - WIRE-WOUND, INSULATED

46. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTERS 33A AND 34A.

a. Radio-frequency Driver Unit.

Ref symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan per unit*	*†Station stock*	*†Region stock*
C2	3DA500-97.1	CAPACITOR: paper; 0.5-mf; 600 v dc (working).	1	*	*
C3	3D9077V	CAPACITOR: variable; 4.5–77-mmf.	1		
C4		CAPACITOR: same as C3.	1		
C5	3DA100-16	CAPACITOR: paper; 0.1-mf; 400 v dc (working).	1	*	*
C7	3D9100V-38	CAPACITOR: variable; 100-mf.	1		
C8		CAPACITOR: same as C7.	1		
C9	3DA8-11	CAPACITOR: paper; 0.008-mf ±20%; 800 v dc (working).	1	*	*
C10	3D9025-43	CAPACITOR: ceramic; 25-mf; 500 v dc (working).	1		*
C11	3K9010-45	CAPACITOR: ceramic; 10-mmf; 500 v dc (working).	1	*	*
C12		CAPACITOR: same as C5.	1	*	*
C13		CAPACITOR: same as C9.	1	*	*
C14		CAPACITOR: same as C9.	1	*	*
C15	3DA500-70.2	CAPACITOR: paper; dual; 0.5-mf per sec; 600 v dc (working).	1	*	*
C16		CAPACITOR: same as C7.	1		
C17		CAPACITOR: same as C7.	1		
C19		CAPACITOR: same as C9.	1	*	*
C20		CAPACITOR: same as C10.	1		*
C21		CAPACITOR: same as C5.	1	*	*
C23		CAPACITOR: same as C9.	1	*	*
C24	3D9150V-20	CAPACITOR: variable; 150-mmf.	1		
C25		CAPACITOR: same as C24.	1		

C26	3DA14	CAPACITOR: paper; 0.01-mf; 1,000 v dc (working).	1	*	*
C27		CAPACITOR: same as C26.	1	*	*
C28	3DB1.6100B	CAPACITOR: paper; 1-mf; 600 v dc (working).	1	*	*
E1	3G112–32.1M	INSULATOR: bushing.	1		*
E2	3G100–56F	INSULATOR: bushing.	1		*
E3	3G100–12M	INSULATOR: bushing.	1		*
E4	3G112–12F	INSULATOR: bushing.	1		*
E6	2Z5848.15	KNOB: black plastic.	1		
E7	2Z9420.5	TERMINAL STRIP: 20 terminals.	1		
E8	2Z9405.1	TERMINAL STRIP: 5 terminals.	1		
J1	4E318B.1	JACK: connecting block; 8-contact.	1		
J2		JACK: same as J1.	1		
J3	2Z5575-1	JACK: coaxial; single contact.	1		
K1	2Z7585–18	RELAY: spdt; polarized; two-winding; 136-ohm; 0.005-amp; 150-v.	1		*
K2		RELAY: same as K1.	1		
K3	2Z7588–17	RELAY: dpdt; 10–16.2-v; 90-ohm ±5%; d-c resistance.	1		*
K4		RELAY: same as K3.	1		*
K5		RELAY: same as K3.	1		*
K6		RELAY: same as K3.	1		*
K7		RELAY: same as K3.	1		*
K8	2Z7599–5	RELAY: spst; 500-v; 0.5-amp contacts.	1		*
K9		RELAY: same as K8.	1		*
L2	3C1081–1513	COIL: r–f; single-winding; (osc grid).	1		

†Parts not stocked in station or region stock are carried in depot stock. *Indicates stock available.

46. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTERS 33A AND 34A (contd).

a. Radio-frequency Driver Unit (contd).

Ref symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan per unit*	†*Station stock*	†*Region stock*
L3		COIL: same as L2.	1		
L4	3C1081–15A	COIL: r–f; single-winding; (osc plate).	1		*
L5		COIL: same as L4.	1		*
L6	3C326–100	CHOKE: 2.5-mh; 50-ohm d-c.	1		*
L7	3C1084Q–2	COIL: r–f; single-winding; (plate tuning).	1		*
L8		COIL: same as L7.	1		*
L9		CHOKE: same as L6.	1		*
L10	3C1084Q–1	COIL: tinned-copper; (43 turns, No. 20).	1		*
L11		COIL: same as L10.	1		*
N1	1F4W1–1	CABLE: coaxial.	1		*
P1	2Z7255–10	PLUG: coaxial; 2-prong.	1		
R1	3Z6200–84	RESISTOR: fixed; 2,000-ohm ±5%; 2-watt.	1		*
R2	2Z7279–25	RESISTOR: variable; 1,000-ohm; 3-watt.	1		*
R3		RESISTOR: same as R2.	1		*
R4	3Z6610–11	RESISTOR: fixed; 10,000-ohm; 1-watt.	1		*
R5	2Z7277.12	RESISTOR: variable; 100-ohm.	1		*
R6		RESISTOR: same as R5.	1		*
R7	3Z6100–17	RESISTOR: fixed; 1,000-ohm; 1-watt.	1		*
R8		RESISTOR: same as R4.	1		*
R9	3Z6010–55	RESISTOR: fixed; 100-ohm; 10-watt.	1		*
R11	3Z6610–134	RESISTOR: fixed; 10,000-ohm; 2-watt.	1		*

R12	3Z4525	RESISTOR: fixed; 1,000-ohm; ½-watt.	1		*
R13	2C4512/49	RESISTOR: fixed; 50,000-ohm; 2-watt.	1		*
R15	3Z6615–43	RESISTOR: fixed; 15,000-ohm; 2-watt.	1		*
R16		RESISTOR: same as R11.	1		*
R17	3Z6100–98	RESISTOR: fixed; 1,000-ohm; 10-watt.	1		*
R18	3Z6610–18	RESISTOR: fixed; 10,000-ohm; 2-watt.	1		*
R19	3Z6615–79	RESISTOR: fixed; 15,000-ohm ±5%; 50-watt.	1		*
R20		RESISTOR: same as R11.	1		*
R21	3Z6500–133	RESISTOR: fixed; 5,000-ohm ±2%; 25-watt.	1		*
R22	3Z6630–7	RESISTOR: fixed; 30,000-ohm; 2-watt.	1		*
R23	3Z6035–21	RESISTOR: fixed; 350-ohm ±5%; 25-watt.	1		*
R24	3Z6160–18	RESISTOR: fixed; 1,600-ohm ±5%; 25-watt.	1		*
R25	3Z6500–132	RESISTOR: fixed; 5,000-ohm ±2%; 50-watt.	1		*
R26	3Z6490	RESISTOR: fixed; 4,900-ohm ±5%; 25-watt.	1		*
R28	3Z6630–55	RESISTOR: fixed; 30,000-ohm; 20-watt.	1		*
R29	3Z6610–30	RESISTOR: fixed; 10,000-ohm; 3-watt.	1		*
R30		RESISTOR: same as R29.	1		*
R31	3Z6610–30	RESISTOR: variable; 10,000-ohm.	1		*
R32		RESISTOR: same as R31.	1		*
R34	3Z6010	RESISTOR: 100-ohm; 1-watt.	1		*
S1	3Z9825–66.23	SWITCH: rotary; (3-position; 2 secs, 3 poles per sec; 500-v 1-amp).	1		*
S2	3Z9825–66.24	SWITCH: rotary; (4-position; 4 secs, 2 poles per sec; 200-v 1-amp).	1		*
S4	4C510479AF	SWITCH: toggle-key; (3-position).	1		
S5	3Z9903A–2.5	SWITCH: rotary; (5-position; 3 secs, 2 poles per sec; 500-v 1-amp).	1		*

†Parts not stocked in station or region stock are carried in depot stock. *Indicates stock available.

46. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTERS 33A AND 34A (contd).

a. Radio-frequency Driver Unit (contd).

Ref symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan per unit*	*†Station stock*	*†Region stock*
S6		SWITCH: same as S5.	1		*
V1	2T94	TUBE VT–94.	1	*	*
V2	2V802	TUBE type 802.	1	*	*
V3	2T100	TUBE VT–100.	1	*	*
V4	2T260	TUBE VT–260.	1	*	*
V5	2T90	TUBE VT–90.	1	*	*
X1	2Z8678.56	SOCKET: tube; 8-prong.	1		*
X2	2Z8677.20	SOCKET: tube; 7-prong.	1		*
X3	2Z8763	SOCKET: tube; 5-prong.	1		*
X4		SOCKET: same as X1.	1		*
X5		SOCKET: same as X1.	1		*
X9	2Z8761–12	SOCKET: crystal holder; 3-prong.	1		*
X10		SOCKET: same as X9.	1		*

b. Radio-frequency Power Amplifier Unit.

C41	3D9100–98	CAPACITOR: mica; 0.0001-mf; 1,200 v dc (working).	1		*
C42	3DA100–16	CAPACITOR: paper; 0.1-mf; 400 v dc (working).	1		*
C43	3DA8–11.1	CAPACITOR: paper; 0.008-mf; 800 v dc (working).	1	*	*
C44		CAPACITOR: same as C43.	1	*	*
C45	3DA10–81.2	CAPACITOR: paper; 0.01-mf; 1,600 v dc (working).	1	*	*
C46	3D9240	CAPACITOR: variable; 32 to 240-mmf; 2-sec.	1		
C47		CAPACITOR: same as C46.	1		

C48	3DA2–56.1	CAPACITOR: mica; 0.002-mf; 6,000 v dc (working).	1		*
C49		CAPACITOR: same as C48.	1		*
E1	3G112–32.1M	INSULATOR: bushing.	1		*
E2	3G100-56F	INSULATOR: bushing.	1		*
E10	3G11–148	INSULATOR: coil-base.	1		*
E11	2Z5822–30	KNOB: black plastic.	1		
E13	3G1250–16.1	INSULATOR: 1-inch; stand-off.	1		*
E12	2Z3269–1	COUPLING: flexible; for ¼" shaft.	1		
E14	3G1250–64.3	INSULATOR: 4-inch; stand-off.	1		*
E15	2Z9414.9	TERMINAL STRIP: 14-contact.	1		
I1	2Z5878.2	LAMP: pilot; miniature bayonet-base; 12–16 v; 0.1 amp.	1	*	*
J6	2Z5594.18	JACK BAR: female; 6-contact.	1		
J7		JACK BAR: same as J6.	1		
K11	2Y7589–17	RELAY: dpdt; coil 22- to 28-v d-c; 194-ohm; 0.1-amp; 3-watt; contacts 110-v a-c, 15-amp.	1		*
L16	3C326–300.2	COIL: r–f; choke; 1.0-mh; 0.3-amp; 10-ohm d-c resistance.	1		*
L17	2C6733A/C2	COIL: r–f; frequency range 3–6 mc.	1		
L18		COIL: same as L17.	1		
L17	2C6733A/C1	COIL: r–f; frequency range 4.5–9 mc.	1		
L18		COIL: same as L17.	1		
L17	2C6733A/C3	COIL: r–f; frequency range 9–13 mc.	1		
L18		COIL: same as L17.	1		
L19	3C358	COIL: r–f; choke; 1.1-mh; 0.8-amp; 6-ohm d-c resistance.	1		*
R51	3Z6300–9	RESISTOR: 3,000-ohm; 2-watt.	1		*

†Parts not stocked in station or region stock are carried in depot stock. *Indicates stock available.

46. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTERS 33A AND 34A (contd).

b. Radio-frequency Power Amplifier Unit (contd).

Ref symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan per unit*	*†Station stock*	*†Region stock*
R52	3Z6400–3	RESISTOR: 4,000-ohm ±5%; 2-watt.	1		*
R53	3Z6100–99	RESISTOR: 1,000-ohm ±5%; 2-watt.	1		*
R54	3Z6005–9	RESISTOR: 50-ohm; ½-watt.	1		*
R55		RESISTOR: same as R54.	1		*
R56	3Z6010–7	RESISTOR: 100-ohm; 2-watt.	1		*
V11	2T144	TUBE VT–144.	1	*	*
V12		TUBE: same as V11.	1	*	*
X11	2Z8690–3	SOCKET: tube; 7-prong.	1		*
X12		SOCKET: same as X11.	1		*
X13	2Z5991	LAMP ASSEMBLY: pilot; miniature bayonet base; 12–16-v; at 0.1 amp.	1	*	*

c. Meter Panel.

M1	3F8300–28	METER: 0 to 300-v a-c; ±2%; SC spec 71–515B.	1		*
M2	3F902–13	METER: 0 to 500-μa d-c; multiscale; ±2%; alternate scales 0 to 1, 0 to 5, 0 to 25.	1		*
R61	3Z6006B2–2	RESISTOR: 62.5-ohm ±1%; 1-watt.	1		*
R62	3Z6002G7–3	RESISTOR: 27.8-ohm ±1%; 1-watt.	1		*
R63		RESISTOR: same as R62.	1		*
R64	3Z5995–17	RESISTOR: 5.1-ohm ±1%; 1-watt.	1		*
R65	3Z6025–45	RESISTOR: 250-ohm ±1%; 1-watt.	1		*
R66	3Z5992–16	RESISTOR: 2.53-ohm ±1%; 1-watt.	1		*
R67	3Z5972–3	RESISTOR: 0.25-ohm ±2.5%; 1-watt.	1		*

R68		RESISTOR: same as R67.	1		*
S11	2Z9825–33.8	SWITCH: rotary; (8-position; 2 secs, 1 pole per sec.; 200-v; 0.5-amp contact).	1		*

d. Audio Amplifier Unit, or Voltage Divider Unit.

‡C61	3D9050–49.3	CAPACITOR: ceramic; 50-mmf; 500 v dc (working).	1	*	*
‡C62		CAPACITOR: same as C61.	1	*	*
‡C63	3DB20–16	CAPACITOR: electrolytic; dual; 20-mf per sec; 150 v dc (working).	1	*	*
C64	3DA500–70.1	CAPACITOR: paper; dual; 0.5-mf per sec; 600 v dc (working).	1	*	*
‡C65	3DA30–16	CAPACITOR: paper; 0.03-mf; 800 v dc (working).	1	*	*
‡C66		CAPACITOR: same as C65.	1	*	*
‡C67	3DA100–100.1	CAPACITOR: paper; 0.1-mf; 3,000 v dc (working).	1	*	*
‡C68		CAPACITOR: same as C67.	1	*	*
‡C69	3DA500–97.1	CAPACITOR: paper; 0.5-mf; 600 v dc (working).	1	*	*
‡C70		CAPACITOR: same as C64.	1	*	*
E1	3G117–32.1M	INSULATOR: bushing.	1		*
E2	3G100–56F	INSULATOR: bushing.	1		*
E15	2Z9414.9	TERMINAL STRIP: 14-contact.	1		
‡ HS1	4B1181	HANDSET.	1		*
J11	2Z5523.7	JACK: microphone; 4-contact.	1		
‡ L26	3C1987–13	CHOKE: filter; 350-h; 0.01-amp; 4,700-ohm d-c resistance.	1		*
‡ L27		CHOKE: same as L26.	1		*
‡P2	2Z7114.22	PLUG: microphone; 4-contact.	1		*
‡R71	3Z6725–4	RESISTOR: 250,000-ohm; 2-watt.	1	*	*
‡R72		RESISTOR: same as R71.	1	*	*

†Parts not stocked in station or region stock are carried in depot stock. *Indicates stock available. ‡Not used in Radio Transmitter 34A.

46. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTERS 33A AND 34A (contd).

d. Audio Amplifier Unit, or Voltage Divider Unit (contd).

Ref symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan per unit*	*†Station stock*	*†Region stock*
‡R73	3Z6012A5	RESISTOR: 125-ohm; ½-watt.	1	*	*
‡R74	3Z6630–39	RESISTOR: 30,000-ohm; 3-watt.	1	*	*
‡R75		RESISTOR: same as R74.	1	*	*
‡R76	3Z6801–4	RESISTOR: 1-meg; 2-watt.	1	*	*
‡R77	3Z6610–5	RESISTOR: 10,000-ohm; 1-watt.	1	*	*
‡R78	2C4197/41	RESISTOR: 2,000-ohm; ½-watt.	1	*	*
‡R79	2C4197/42	RESISTOR: 10,000-ohm; ½-watt.	1	*	*
‡R80		RESISTOR: same as R79.	1	*	*
‡R81	3Z6730–6	RESISTOR: 300,000-ohm; 3-watt.	1	*	*
‡R82		RESISTOR: same as R81.	1	*	*
‡R83	2C4512/47	RESISTOR: 100,000-ohm; ½-watt.	1	*	*
‡R84		RESISTOR: same as R83.	1	*	*
‡R85	2C4197/48	RESISTOR: 1-meg; ½-watt.	1	*	*
‡R86	2Z7270.1	RESISTOR: 50,000-ohm; 3-watt.	1		*
‡R87		RESISTOR: same as R81.	1	*	*
R88	3Z5417A5–2	RESISTOR: wire-wound; 1,750-ohm; 110-watt.	1	*	*
R89	3Z5396	RESISTOR: wire-wound; 960-ohm; 33-watt.	1	*	*
R90	3Z6059	RESISTOR: wire-wound; 590-ohm; 33-watt.	1		*
R91	3Z5412E5	RESISTOR: wire-wound; 1,250-ohm; 160-watt.	1	*	*
R92	3Z5360–1	RESISTOR: wire-wound; 600-ohm; 40-watt.	1	*	*

‡T1	2Z9631.65	TRANSFORMER: input; operating fr 300 to 2,500 cps; impedance ratio 1–2/3–4 = 50/20,000; d-c resistance 1–2 46 ohms, 3–4 5,000 ohms.	1		*
‡T2	2Z9631.64	TRANSFORMER: input; operating fr 300 to 2,500 cps; impedance ratio 1–2 or 3–4 = 5–6 or 7–8 = 20,000/500,000 ohms; d-c resistance 1–2 and 3–4 1,750 ohms; 5–6 and 7–8 1,200 ohms.	1		*
‡T3	2Z9632.75	TRANSFORMER: output; d-c resistance 1–2 4.1 ohms; 3–4 34 ohms; 5–6 17.3 ohms; 7–8 175 ohms.	1		*
*V16	2T87	TUBE VT–87.	1	*	*
*V17		TUBE: same as V16.	1	*	*
*V18	2T163	TUBE VT–163.	1	*	*
*V19	2V828	TUBE: type 828.	1	*	*
*V20		TUBE: same as V19.	1	*	*
*V21		TUBE: same as V5.	1	*	*
‡X16	2Z8678.56	SOCKET: tube; 8-prong.	1		*
‡X17		SOCKET: same as X16.	1		*
‡X18		SOCKET: same as X16.	1		*
‡X19	2Z8763	SOCKET: tube; 5-prong.	1		*
‡X20		SOCKET: same as X19.	1		*
‡X21		SOCKET: same as X16.	1		*

e. Power Unit.

A1	6Z3856–8.1	FILTER: air; dustop.	1	*	*
B1	3H392	MOTOR: fan; 12-in; 3-paddle; bucket-blade; (230 v; 50 to 60 cps).	1		*
C80	3DB125–1	CAPACITOR: electrolytic; 125-mf; 350 v dc (working).	1	*	*
C81		CAPACITOR: same as C80.	1	*	*
C82	3DB1.6100C	CAPACITOR: paper; 1-mf; 600 v dc (working).	1	*	*
C83	3DB24–1	CAPACITOR: electrolytic; 16-mf; 350 v dc (working).	1	*	*
C84	3DB16–11	CAPACITOR: electrolytic; 24-mf; 350 v dc (working).	1	*	*

†Parts not stocked in station or region stock are carried in depot stock. *Indicates stock available. ‡Not used in Radio Transmitter 34A.

46. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTERS 33A AND 34A (contd).

e. Power Unit (contd).

Ref symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan per unit*	*†Station stock*	*†Region stock*
C85		CAPACITOR: same as C84.	1	*	*
C86	3DB4–37	CAPACITOR: paper; 4-mf; 2,000 v dc (working).	1	*	*
C87		CAPACITOR: same as C86.	1	*	*
C88	3DB4–54	CAPACITOR: paper; 4-mf 1,000 v dc (working).	1	*	*
C89		CAPACITOR: same as C88.	1	*	*
COR1	3H4626	RECTIFIER: copper-oxide; rectox-unit; 0.64-amp; max input 45.6-v a-c; max output 28.8-v d-c.	1		*
COR2		RECTIFIER: same as COR1.	1		*
E1	3G112–32.1M	INSULATOR: bushing.	1		*
E2	3G100–56F	INSULATOR: bushing.	1		*
E11	2Z5822–30	KNOB: black plastic.	1		
E15	2Z9414.9	TERMINAL STRIP: 14-contact.	1		
E16	3G1250–8.12	INSULATOR: ½-in. stand-off.	1		*
E17	2Z9410.12	TERMINAL STRIP: 10-terminal.	1		
E18	2Z9402.54	TERMINAL STRIP: 2-terminal.	1		
E19	2Z9412.20	TERMINAL STRIP: 12-terminal.	1		
E20	3G1250–22.1	INSULATOR: cone.	1		*
F1	3Z2015	FUSE: plug-type; 15-amp; 125-v.	1	*	*
F2		FUSE: same as F1.	1	*	*
F3	3Z2001	FUSE: plug-type; 1-amp; 125-v.	1	*	*
F4	3Z2602.11	FUSE: plug-type; 2-amp; 125-v.	1	*	*

F5	3Z2010	FUSE: plug-type; 10-amp; 125-v.	1	*	*
F6		FUSE: same as F5.	1	*	*
K16	2Z7588–30	RELAY: power; dpst: (normal open; contacts 220-v, 15-amp; coil 11.5-v min operation, 4.5-watt; d-c resistance of coil 140 ohms).	1		*
K17	2Z7586–6	RELAY: time-delay; spst; (normal open; contacts 100-v, 1-amp).	1		*
K18	2Z7590.29	RELAY: plate-power; dpst; (normal open; contacts 220-v, 15-amp; coil 120-v, 4.5-watt).	1		*
L30	3C1987–04	CHOKE: filter; 0.23-h; 1.25-amp; 3.6-ohm d-c resistance.	1		*
L31	3C1987–14.2	CHOKE: filter; 5-h; 0.3-amp; 64-ohm d-c resistance.	1		*
L32	3C1987–15	CHOKE: filter; 8-h; 0.4-amp; 64-ohm d-c resistance.	1		*
L33	3C1987–16	CHOKE: filter; 3-h; 0.4-amp; 55-ohm d-c resistance.	1		*
L34	3C1987–17	COIL: audio choke; 5-h; 71-ohm d-c resistance.	1		*
L35		COIL: same as L34.	1		*
R101	3Z4905–1	RESISTOR: wire-wound; 105-ohm; 200-watt.	1	*	*
R102	3Z5415.3	RESISTOR: wire-wound; 1,500-ohm; 25-watt.	1	*	*
R103	3Z6025–33	RESISTOR: 250-ohm; 3-watt.	1	*	*
R104	3Z6005–9	RESISTOR: 50-ohm; ½-watt.	1		*
R105	3Z6015–24	RESISTOR: 150-ohm; 1-watt.	1		*
R106	3Z6625–146	RESISTOR: wire-wound; 25,000-ohm ±1%; 40-watt.	1		*
R107		RESISTOR: same as R106.	1		*
R108	3Z6801–44	RESISTOR: 1-meg ±1%; 1-watt.	1		*
S16	3Z9857–2.1	SWITCH: toggle; dpst.	1		*
S17	3Z98374	SWITCH: rotary; (6-position; 1 sec, 1 pole).	1		*
S18	3Z9560–7	SWITCH: door; single-circuit; 250-v; 15-amp.	1		*
T6	2Z9621–18	TRANSFORMER: power.	1		*

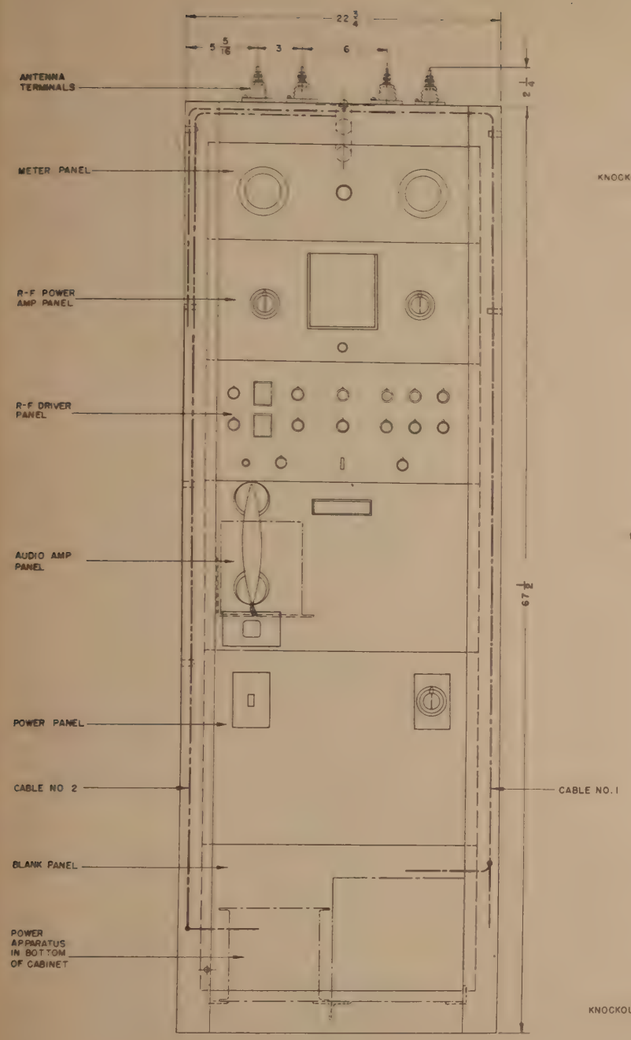
†Parts not stocked in station or region stock are carried in depot stock. *Indicates stock available.

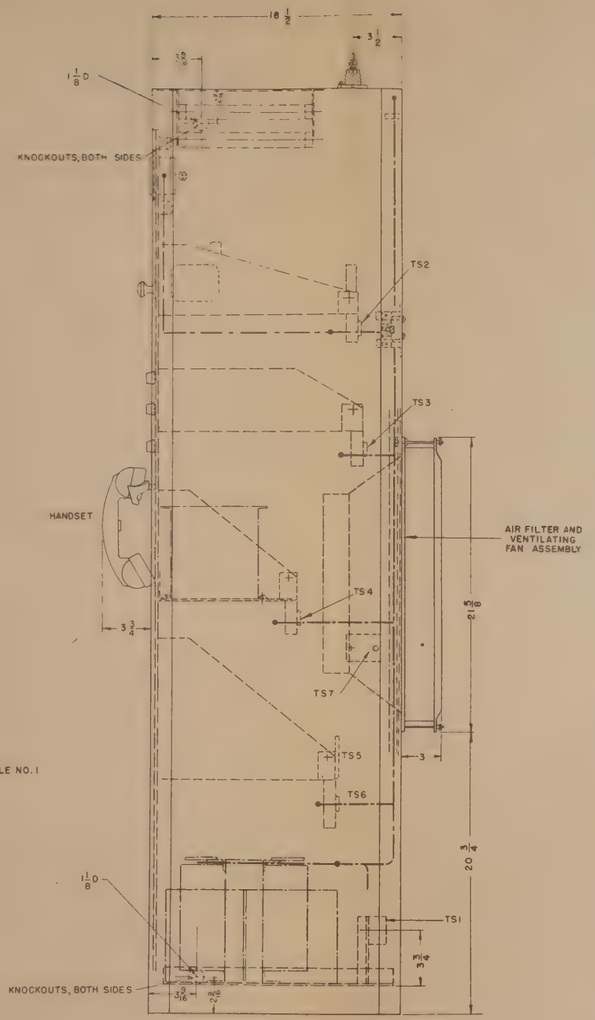
46. MAINTENANCE PARTS LIST FOR RADIO TRANSMITTERS 33A AND 34A (contd).

e. Power Unit (contd).

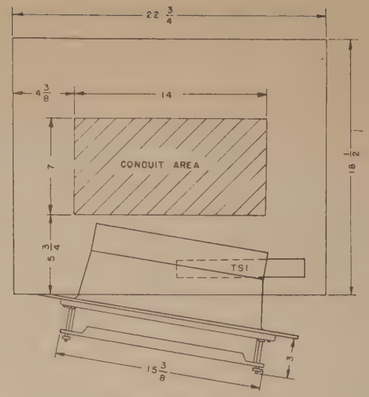
Ref symbol	*Signal Corps stock No.*	*Name of part and description*	*Quan per unit*	†*Station stock*	†*Region stock*
T7	2Z9621-19	TRANSFORMER: power.	1		*
T8	2Z9601.15	TRANSFORMER: power.	1		*
V26		TUBE: same as V3.	1	*	*
V27	2T244	TUBE VT-244.	1	*	*
V28	2V249B	TUBE VT-249B.	1	*	*
V29		TUBE: same as V28.	1	*	*
V30	2T46A	TUBE VT-46A.	1	*	*
V31		TUBE: same as V30.	1	*	*
X26	2Z8763	SOCKET: tube; 5-prong.	1		*
X27	2Z8678.56	SOCKET: tube; 8-prong; ceramic	1		*
X28	2Z8762	SOCKET: tube; 4-prong.	1		*
X29		SOCKET: same as X28.	1		*
X30		SOCKET: same as X28.	1		*
X31		SOCKET: same as X28.	1		*

†Parts not stocked in station or region stock are carried in depot stock. *Indicates stock available.

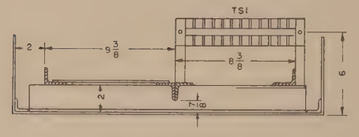




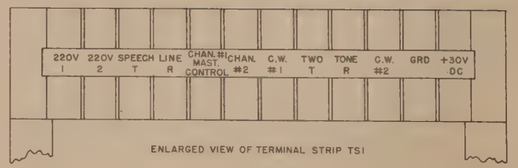
VIEWS OF TRANSMITTER SHOW THE VERTICAL MOUNTING ARRANGEMENT OF THE PANELS USED ON RADIO TRANSMITTER 33A. EXCEPT FOR THE HANDSET, THE OUTSIDE DIMENSIONS ARE THE SAME FOR RADIO TRANSMITTER 34A.



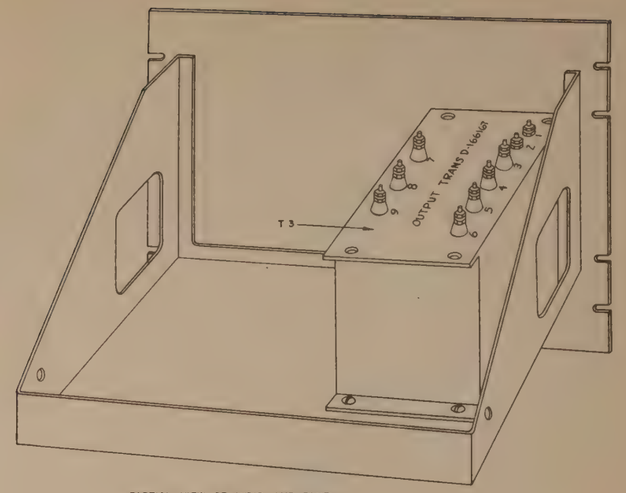
VIEW SHOWING CONDUIT AREA AND DOOR PARTIALLY OPEN



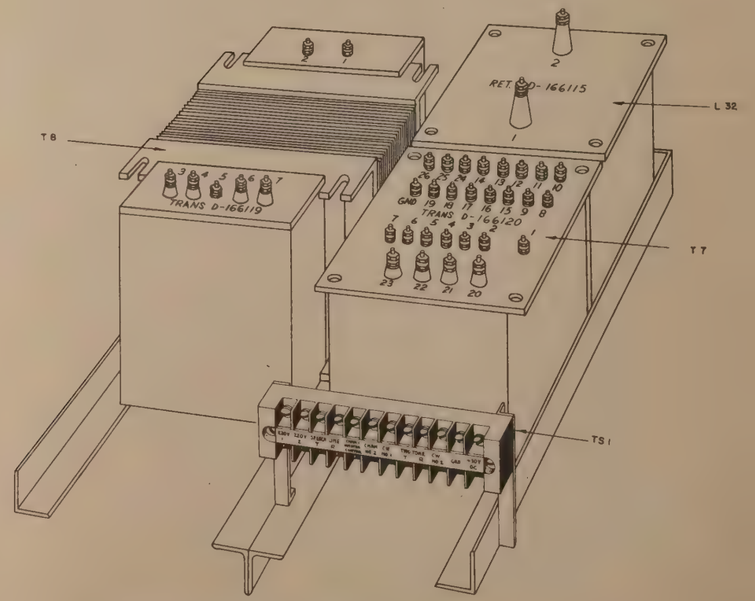
SECTIONAL VIEW AT BOTTOM OF CABINET SHOWING LOCATION OF MAIN TERMINAL STRIP TS1



ENLARGED VIEW OF TERMINAL STRIP TS1



PARTIAL VIEW OF AUDIO AMP. PANEL SHOWING LOCATION OF TRANSFORMER T3



PARTIAL VIEW OF BOTTOM FROM REAR OF CABINET SHOWING LOCATION OF TRANSFORMERS T7, T8, CHOKE L32 AND MAIN TERMINAL STRIP TS1

TL-11052

Figure 27. Radio Transmitters 33A and 34A, outline dimensions.

CAPACITORS

Symbol	Description	Function
C2	0.5 mf	Wave Shaping
C3	4.5 to 77 mmf	Freq. Shift Adjustment
C4	4.5 to 77 mmf	Freq. Shift Adjustment
C5	0.1 mf	Osc. Grid Meter Bypass
C7	100 mmf	Osc. Plate Tuning
C8	100 mmf	Osc. Plate Tuning
C9	0.008 mf	Osc. Plate By-pass
C10	25 mmf	Osc. Plate Blocking
C11	10 mmf	Ext. Osc. Coupling
C12	0.1 mf	1st Amp. Grid Meter Bypass
C13	0.008 mf	1st Amp. Cathode Bypass
C14	0.008 mf	1st Amp. Screen Bypass
C15A	0.5 mf	Osc. Wave Shaping
C15B	0.5 mf	1st Amp. Wave Shaping
C16	100 mmf	1st Amp. Plate Tuning
C17	100 mmf	1st Amp. Plate Tuning
C19	0.008 mf	1st Amp. Plate Bypass
C20	25 mmf	1st Amp. Plate Blocking
C21	0.1 mf	2d Amp. Grid Meter Bypass
C23	0.008 mf	2d Amp. Screen Bypass
C24	150 mmf	2d Amp. Plate Tuning
C25	150 mmf	2d Amp. Plate Tuning
C26	0.01 mf	2d Amp. Plate Bypass
C27	0.01 mf	2d Amp. Plate Bypass
C28	1 mf	Spark Suppressor
C41	0.0001 mf	2d Amp. Plate Blocking
C42	0.1 mf	P.A. Grid Meter Bypass
C43	0.008 mf	P.A. Filament Bypass
C44	0.008 mf	P.A. Filament Bypass
C45	0.01 mf	P.A. Screen Bypass
C46	32 to 240 mmf per section, two sections	P.A. Plate Tuning
C47	32 to 240 mmf per section, two sections	P.A. Plate Tuning
C48	0.002	P.A. Plate Bypass
C49	0.002	P.A. Plate Bypass
C61	50 mmf	V.L. Amp. Grid Bypass
C62	50 mmf	V.L. Amp. Grid Bypass
C63A	20 mf	V.L. Amp. Cathode Bypass
C63B	20 mf	Int. Amp. Grid Bypass
C64A	0.5 mf	400-Volt Filter
C64B	0.5 mf	V.L. Amp. Screen Bypass
C65	0.03	Int. Amp. Plate Blocking
C66	0.03	Int. Amp. Plate Blocking
C67	0.1 mf	Audio Feedback
C68	0.1 mf	Audio Feedback
C69	0.5 mf	Volume Limiter Time Constant
C70A	0.5 mf	200-Volt Filter
C70B	0.5 mf	275-Volt Filter
C80	125 mf	+30-Volt Filter
C81	125 mf	+30-Volt Filter
C82	1 mf	Time Delay Relay Shunt
C83	16 mf	Bias Rectifier Filter
C84	24 mf	Bias Rectifier Filter
C85	24 mf	Grid Bias Filter
C86	4 mf	1,600-Volt Filter
C87	4 mf	1,600-Volt Filter
C88	4 mf	700-Volt Filter
C89	4 mf	700-Volt Filter

FUSES

Symbol	Description	Function
F1	Fuse, 15-amp.	Main Line
F2	Fuse, 15-amp.	Main Line

FUSES—Continued

Symbol	Description	Function
F3	Fuse, 1-amp.	+30-Volt Transformer
F4	Fuse, 2-amp.	Fan
F5	Fuse, 10-amp.	Plate Transformer
F6	Fuse, 10-amp.	Plate Transformer

JACKS

Symbol	Description	Function
J1	Jack—8 Contact	Relay Connecting Block (K1)
J2	Jack—8 Contact	Relay Connecting Block (K2)
J3	Jack—Coaxial	Ext. Oscillator
J6	Jack—Coil	P.A. Plate Coil
J7	Jack—Coil	P.A. Plate Coil
J11	Microphone Jack	Handset Jack

RELAYS

Symbol	Description	Function
K1	SPDT—Polarized	Two-tone Keying
K2	SPDT—Polarized	CW Keying
K3	DPDT, 10-16.2 V	Osc. Grid Switching
K4	DPDT, 10-16.2 V	Osc. Plate Switching
K5	DPDT, 10-16.2 V	1st Amp. Plate Switching
K6	DPDT, 10-16.2 V	2d Amp. Plate Switching
K7	DPDT, 10-16.2 V	Channel Control
K8	SPST, Slow release	Channel Switch Timing
K9	SPST, Slow release	Channel Switch Timing
K11	DPDT, 22-28 V	P.A. Plate Switching
K16	DPST Contactor	Main Power
K17	SPST	Time Delay
K18	DPST Contactor	Plate Power

INDUCTORS

Symbol	Description	Function
L2	RF Coil	Osc. Grid Inductance
L3	RF Coil	Osc. Grid Inductance
L4	RF Coil	Osc. Plate Tuning
L5	RF Coil	Osc. Plate Tuning
L6	RF Choke 2.5 Millihenry	1st Amp. Grid Choke
L7	RF Coil	1st Amp. Plate Tuning
L8	RF Coil	1st Amp. Plate Tuning
L9	RF Choke 2.5 Millihenry	2d Amp. Grid Choke
L10	RF Coil	2d Amp. Plate Tuning
L11	RF Coil	2d Amp. Plate Tuning
L16	RF Choke	P.A. Grid Choke
L17	1.0 Millihenry P.A. Output Coil 3.0-6.0 mc— 9 turns 4.5-9.0 mc— 5 turns 9.0-13.0 mc— 4 turns	P.A. Plate Tuning and Antenna Coupling
L18	Same as L17	P.A. Plate Tuning and Antenna Coupling
L19	RF Choke 1.1 Millihenry	P.A. Plate Choke
L26	Retard Coil 350 Henries	Int. Amp. Plate Choke
L27	Retard Coil 350 Henries	Int. Amp. Plate Choke
L30	Retard Coil 0.23 Henry	+30-Volt Filter Choke

INDUCTORS—Continued

Symbol	Description	Function
L31	Retard Coil 5 Henries	Bias Filter Choke
L32	Retard Coil 8 Henries	1,600-Volt Filter Choke
L33	Retard Coil 3 Henries	1,600-Volt Filter Choke
L34	Retard Coil 5 Henries	700-Volt Filter Choke
L35	Retard Coil 5 Henries	700-Volt Filter Choke

RESISTORS

Symbol	Description	Function
R1	2,000 ohms	K2 Relay Bias
R2	1,000 ohms	Line Compensator
R3	1,000 ohms	Line Compensator
R4	10,000 ohms	Bias Voltage Divider
R5	100 ohms	Line Compensator
R6	100 ohms	Line Compensator
R7	1,000 ohms	Keying Relay
R8	10,000 ohms	Bias Voltage Divider
R9	100 ohms N.I.	Ext. Osc. Load
R11	10,000 ohms	Diode Plate
R12	1,000 ohms	Wave Shaping
R13	50,000 ohms	Oscillator Grid
R15	15,000 ohms	Keying Wave Shaping
R16	10,000 ohms	First Amplifier Grid
R17	1,000 ohms	First Amplifier Cathode
R18	10,000 ohms	First Amplifier Screen
R19	15,000 ohms	Voltage Reducer
R20	10,000 ohms	Second Amplifier Grid
R21	5,000 ohms	Voltage Reducer
R22	30,000 ohms	Second Amplifier Screen
R23	350 ohms	Voltage Reducer
R24	1,600 ohms	Voltage Reducer
R25	5,000 ohms	Voltage Reducer
R26	4,900 ohms	Voltage Reducer
R28	30,000 ohms	Voltage Reducer
R29	10,000 ohms	Second Amplifier Plate Load
R30	10,000 ohms	Second Amplifier Plate Load
R31	10,000 ohms	First Amplifier Plate
R32	10,000 ohms	First Amplifier Plate
R34	100 ohms	Spark Suppressor
R51	3,000 ohms	P.A. Grid Leak
R52	4,000 ohms	Bias Voltage Divider
R53	1,000 ohms	Bias Voltage Divider
R54	50 ohms	P.A. Grid
R55	50 ohms	P.A. Grid
R56	100 ohms	P.A. Screen
R61	62.5 ohms	Osc. Grid Meter Shunt
R62	27.8 ohms	1st Amp. Grid Meter Shunt
R63	27.8 ohms	2d Amp. Grid Meter Shunt
R64	5.1 ohms	P.A. Grid Meter Shunt
R65	250 ohms	700-V Voltmeter Shunt
R66	2.53 ohms	1,600-V Voltmeter Shunt
R67	0.25 ohms	Modulator Space Meter Shunt
R68	0.25 ohms	P.A. Space Meter Shunt
R71	0.25 megohm	Input Trans. Terminating
R72	0.25 megohm	Input Trans. Terminating
R73	125 ohms	V.L. Audio Amp. Cathode
R74	30,000 ohms	V.L. Audio Amp. Screen
R75	30,000 ohms	V.L. Audio Amp. Screen
R76	1 megohm	Interstage Trans. Terminating
R77	10,000 ohms	Int. Audio Amp. Bias Voltage Divider

RESISTORS—Continued

Symbol	Description	Function
R78	2,000 ohms	Int. Audio Amp. Bias Voltage Divider
R79	10,000 ohms	Int. Audio Amp. Cathode
R80	10,000 ohms	Int. Audio Amp. Cathode
R81	0.3 megohm	Audio Feedback
R82	0.3 megohm	Audio Feedback
R83	0.1 megohm	Modulator Grid
R84	0.1 megohm	Modulator Grid
R85	1 megohm	Vclume Limiter Plate
R86	50,000 ohms	Volume Limiter Adjustment
R87	0.3 megohm	Voltage Divider
R88	1,750 ohms	Voltage Divider
R89	960 ohms	Voltage Divider
R90	590 ohms	Voltage Divider
R91	1,250 ohms	Voltage Divider
R92	600 ohms	Voltage Divider
R101	105 ohms	Time Delay Rect. Filament
R102	1,500 ohms	Bias Voltage Divider
R103	250 ohms	Bias Voltage Divider
R104	150 ohms	Bias Voltage Divider
R105	150 ohms	Microphone Series
R106	25,000 ohms	1,600-V Voltmeter Series
R107	25,000 ohms	1,600-V Voltmeter Series
R108	1 megohm	700-V Voltmeter Series

SWITCHES

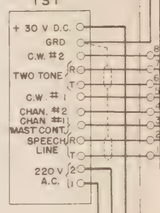
Symbol	Description	Function
S1	Rotary, 6-pole, 3-position	Emission Selector
S2	Rotary, 8-pole, 4-position	Local-Remote Control
S4	3-position Key	Carrier Test Key
S5	Rotary, 6-pole, 4-position	Band Selector Switch
S6	Rotary, 6-pole, 4-position	Band Selector Switch
S11	Rotary, 2-pole, 8-position	D-c Meter Switch
S16	DPST Toggle	Main Power
S17	Rotary, 1-pole 6-position	Autotransformer
S18	Door Switch	Safety Switch

TRANSFORMERS

Symbol	Description	Function
T1	Input	Audio Input
T2	Input	Audio Interstage
T3	Output	Modulator Output
T6	Power	+30 Volt
T7	Power	Filament and Bias
T8	Power	Plate

MISCELLANEOUS

Symbol	Description	Function
B1	Fan Motor	Blower
COR1	Rectox Unit	+30-Volt Rectifier
COR2	Rectox Unit	+30-Volt Rectifier
I1	12 to 16-Volt Lamp	Pilot Lamp
M1	AC Voltmeter 0 to 300-V	AC Line Voltmeter
M2	Microammeter 0 to 500 μa	DC Multi-Scale Meter
P2	Microphone Plug 4-contact	Handset Plug



CAPACITORS

Symbol	Description	Function
C2	0.5 mf	Wave Shaping
C3	4.5 to 77 mmf	Freq. Shift Adjustment
C4	4.5 to 77 mmf	Freq. Shift Adjustment
C5	0.1 mf	Osc. Grid Meter Bypass
C7	100 mf	Osc. Plate Tuning
C8	100 mf	Osc. Plate Tuning
C9	0.008 mf	Osc. Plate Bypass
C10	25 mmf	Osc. Plate Blocking
C11	10 mmf	Ext. Osc. Coupling
C12	0.1 mf	1st Amp. Grid Meter Bypass
C13	0.008 mf	1st Amp. Cathode Bypass
C14	0.008 mf	1st Amp. Screen Bypass
C15A	0.5 mf	Osc. Wave Shaping
C15B	0.5 mf	1st Amp. Wave Shaping
C16	100 mmf	1st Amp. Plate Tuning
C17	100 mmf	1st Amp. Plate Tuning
C19	0.008 mf	1st Amp. Plate Bypass
C20	25 mmf	1st Amp. Plate Blocking
C21	0.1 mf	2d Amp. Grid Meter Bypass
C23	0.008 mf	2d Amp. Screen Bypass
C24	150 mmf	2d Amp. Plate Tuning
C25	150 mmf	2d Amp. Plate Tuning
C26	0.01 mf	2d Amp. Plate Bypass
C27	0.01 mf	2d Amp. Plate Bypass
C28	1 mf	Spark Suppressor
C41	0.0001 mf	2d Amp. Plate Blocking
C42	0.1 mf	P.A. Grid Meter Bypass
C43	0.008 mf	P.A. Filament Bypass
C44	0.008 mf	P.A. Filament Bypass
C45	0.01 mf	P.A. Screen Bypass
C46	32 to 240 mmf per section, two sections	P.A. Plate Tuning
C47	32 to 240 mmf per section, two sections	P.A. Plate Tuning
C48	0.002	P.A. Plate Bypass
C49	0.002	P.A. Plate Bypass
C64A	0.5 mf	400-Volt Filter
C80	125 mf	+30-Volt Filter
C81	125 mf	+30-Volt Filter
C82	1 mf	Time Delay Relay Shunt
C83	16 mf	Bias Rectifier Filter
C84	24 mf	Bias Rectifier Filter
C85	24 mf	Grid Bias Filter
C86	4 mf	1,600-Volt Filter
C87	4 mf	1,600-Volt Filter
C88	4 mf	700-Volt Filter
C89	4 mf	700-Volt Filter

FUSES

Symbol	Description	Function
F1	Fuse, 15-amp.	Main Line
F2	Fuse, 15-amp.	Main Line
F3	Fuse, 1-amp.	+30-Volt Transformer
F4	Fuse, 2-amp.	Fan
F5	Fuse, 10-amp.	Plate Transformer
F6	Fuse, 10-amp.	Plate Transformer

JACKS

Symbol	Description	Function
J1	Jack—8-contact	Relay Connecting Block (K1)
J2	Jack—8-contact	Relay Connecting Block (K2)
J3	Jack—Coaxial	Ext. Oscillator
J6	Jack—Coil	P.A. Plate Coil
J7	Jack—Coil	P.A. Plate Coil

RELAYS

Symbol	Description	Function
K1	SPDT—Polarized	Two-tone Keying
K2	SPDT—Polarized	CW Keying
K3	DPDT, 10 to 16.2-v	OSC. Grid Switching
K4	DPDT, 10 to 16.2-v	OSC. Plate Switching
K5	DPDT, 10 to 16.2-v	1st Amp. Plate Swtching
K6	DPDT, 10 to 16.2-v	2d Amp. Plate Switching
K7	DPDT, 10 to 16.2-v	Channel Control
K8	SPST, Slow release	Channel Switch Timing
K9	SPST, Slow release	Channel Switch Timing
K11	DPDT, 22 to 28-v	P.A. Plate Switching
K16	DPST, Contactor	Man Power
K17	SPST	Time Delay
K18	DPST, Contactor	Plate Power

INDUCTORS

Symbol	Description	Function
L2	RF Coil	OSC. Grid Inductance
L3	RF Coil	OSC. Grid Inductance
L4	RF Coil	OSC. Plate Tuning
L5	RF Coil	OSC. Plate Tuning
L6	RF Choke 2.5 Millihenry	1st Amp. Grid Choke
L7	RF Coil	1st Amp. Plate Tuning
L8	RF Coil	1st Amp. Plate Tuning
L9	RF Choke 2.5 Millihenry	2d Amp. Grid Choke
L10	RF Coil	2d Amp. Plate Tuning
L11	RF Coil	2d Amp. Plate Tuning
L16	RF Choke 1.0 Millihenry	P.A. Grid Choke
L17	P.A. Output Coil 3.0-6.0 mc—9 turns 4.5-9.0 mc—5 turns 9.0-13.0 mc—4 turns	P.A. Plate Tuning and Antenna Coupling
L18	Same as L17	P.A. Plate Tuning and Antenna Coupling
L19	RF Choke 1.1 Millihenry	P.A. Plate Choke
L30	Retard Coil 0.23 Henry	+30-Volt Filter Choke
L31	Retard Coil 5 Henries	Bias Filter Choke
L32	Retard Coil 8 Henries	1,600-Volt Filter Choke
L33	Retard Coil 3 Henries	1,600-Volt Filter Choke
L34	Retard Coil 5 Henries	700-Volt Filter Choke
L35	Retard Coil 5 Henries	700-Volt Filter Choke

RESISTORS

Symbol	Description	Function
R1	2,000 ohms	K2 Relay Bias
R2	1,000 ohms	Line Compensator
R3	1,000 ohms	Line Compensator
R4	10,000 ohms	Bias Voltage Divider
R5	100 ohms	Line Compensator
R6	100 ohms	Line Compensator
R7	1,000 ohms	Keying Relay
R8	10,000 ohms	Bias Voltage Divider
R9	100 ohms N.I.	Ext. Osc. Load

RESISTORS—Continued

Symbol	Description	Function
R11	10,000 ohms	Diode Plate
R12	1,000 ohms	Wave Shaping
R13	50,000 ohms	Oscillator Grid
R15	15,000 ohms	Keying Wave Shaping
R16	10,000 ohms	First Amplifier Grid
R17	1,000 ohms	1st Amp. Cathode
R18	10,000 ohms	1st Amp. Screen
R19	15,000 ohms	Voltage Reducer
R20	10,000 ohms	2d Amp. Grid
R21	5,000 ohms	Voltage Reducer
R22	30,000 ohms	2d Amp. Screen
R23	350 ohms	Voltage Reducer
R24	1,600 ohms	Voltage Reducer
R25	5,000 ohms	Voltage Reducer
R26	4,900 ohms	Voltage Reducer
R28	30,000 ohms	Voltage Reducer
R29	10,000 ohms	2d Amp. Plate Load
R30	10,000 ohms	2d Amp. Plate Load
R31	10,000 ohms	1st Amp. Plate
R32	10,000 ohms	1st Amp. Plate
R34	100 ohms	Spark Suppressor
R51	3,000 ohms	P.A. Grid Leak
R52	4,000 ohms	Bias Voltage Divider
R53	1000 ohms	Bias Voltage Divider
R54	50 ohms	P.A. Grid
R55	50 ohms	P.A. Grid
R56	100 ohms	P.A. Screen
R61	62.5 ohms	Osc. Grid Meter Shunt
R62	27.8 ohms	1st Amp. Grid Meter Shunt
R63	27.8 ohms	2d Amp. Grid Meter Shunt
R64	5.1 ohms	P.A. Grid Meter Shunt
R65	250 ohms	700-V. Voltmeter Shunt
R66	2.53 ohms	1,600-V. Voltmeter Shunt
R67	0.25 ohms	Modulator Space Meter Shunt
R68	0.25 ohms	P.A. Space Meter Shunt
R88	1,750 ohms	Voltage Divider
R89	960 ohms	Voltage Divider
R90	590 ohms	Voltage Divider
R91	1,250 ohms	Voltage Divider
R92	600 ohms	Voltage Divider
R101	105 ohms	Time Delay Rect. Filament
R102	1,500 ohms	Bias Voltage Divider
R103	250 ohms	Bias Voltage Divider
R104	150 ohms	Bias Voltage Divider
R105	150 ohms	Microphone Series
R106	25,000 ohms	1,600-V. Voltmeter Series
R107	25,000 ohms	1,600-V. Voltmeter Series
R108	1 megohm	700-V. Voltmeter Series

SWITCHES

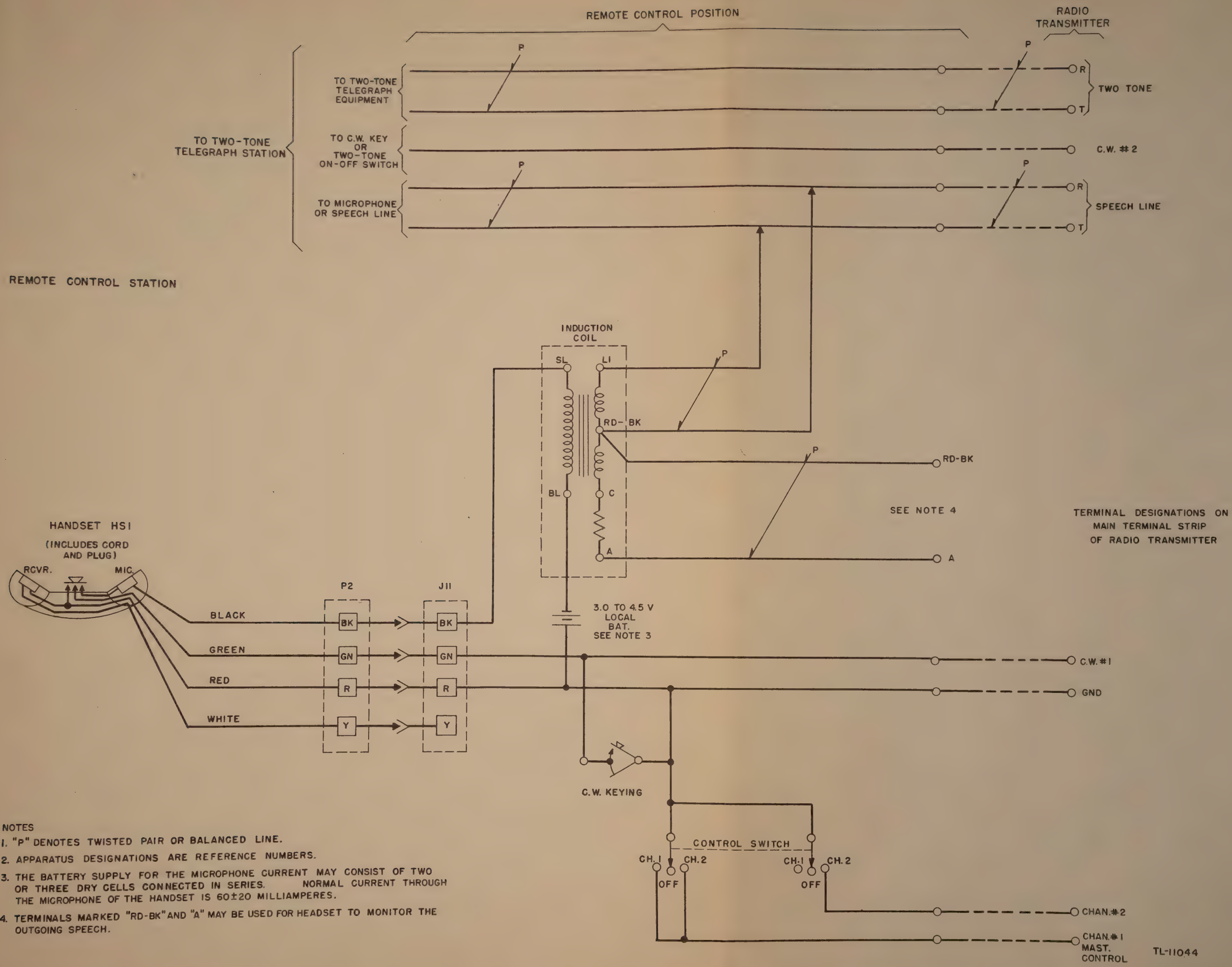
Symbol	Description	Function
S1	Rotary, 6-pole, 3-position	Emission Selector
S2	Rotary, 8-pole, 4-position	Local-Remote Control
S4	3-position key	Carrier Test Key
S5	Rotary, 6-pole, 4-position	Band Selector Switch
S6	Rotary, 6-pole, 4-position	Band Selector Switch
S11	Rotary, 2-pole, 8-position	DC Meter Switch
S16	DPST Toggle	Main Power
S17	Rotary, 1-pole, 6-position	Autotransformer
S18	Door Switch	Safety Switch

TRANSFORMERS

Symbol	Description	Function
T1	Input	Audio Input
T2	Input	Audio Interstage
T3	Output	Modulator Output
T6	Power	+30 Volt
T7	Power	Filament and Bias
T8	Power	Plate

MISCELLANEOUS

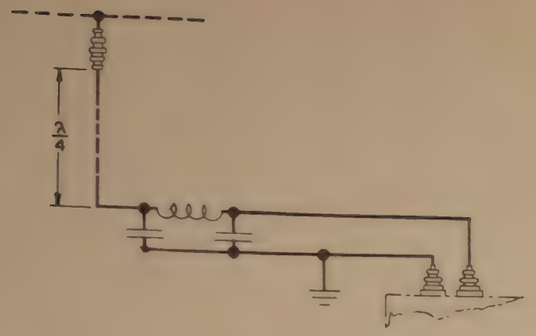
Symbol	Description	Function
B1	Fan Motor	Blower
COR1	Rectox Unit	+30-Volt Rectifier
COR2	Rectox Unit	+30-Volt Rectifier
I1	12 to 16-Volt Lamp	Pilot Lamp
M1	AC Voltmeter 0 to 300-V	A-C Line Voltmeter
M2	Microammeter 0 to 500-μa	D-C Multi-Scale Meter
P2	Microphone Plug 4-contact	Handset Plug



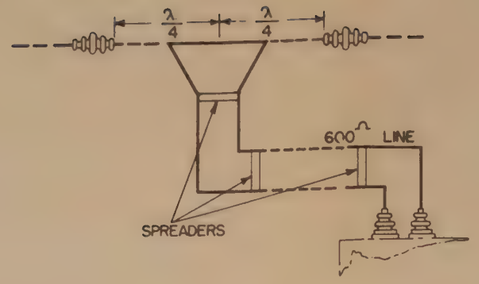
NOTES

1. "P" DENOTES TWISTED PAIR OR BALANCED LINE.
2. APPARATUS DESIGNATIONS ARE REFERENCE NUMBERS.
3. THE BATTERY SUPPLY FOR THE MICROPHONE CURRENT MAY CONSIST OF TWO OR THREE DRY CELLS CONNECTED IN SERIES. NORMAL CURRENT THROUGH THE MICROPHONE OF THE HANDSET IS 60±20 MILLIAMPERES.
4. TERMINALS MARKED "RD-BK" AND "A" MAY BE USED FOR HEADSET TO MONITOR THE OUTGOING SPEECH.

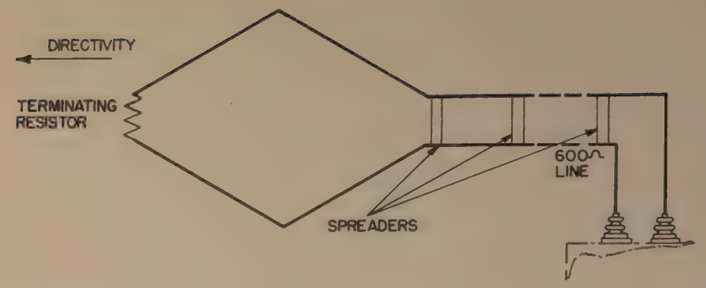
Figure 30. Recommended remote control circuit, schematic diagram.



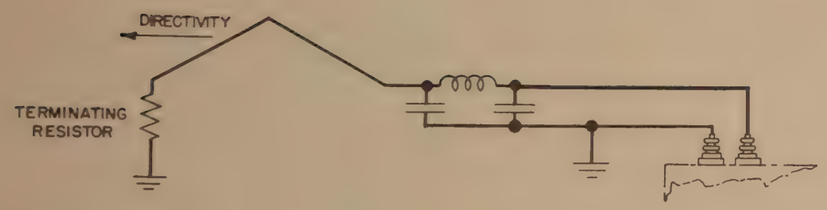
VERTICAL QUARTER-WAVE
3-6 MC
(SIDE VIEW)



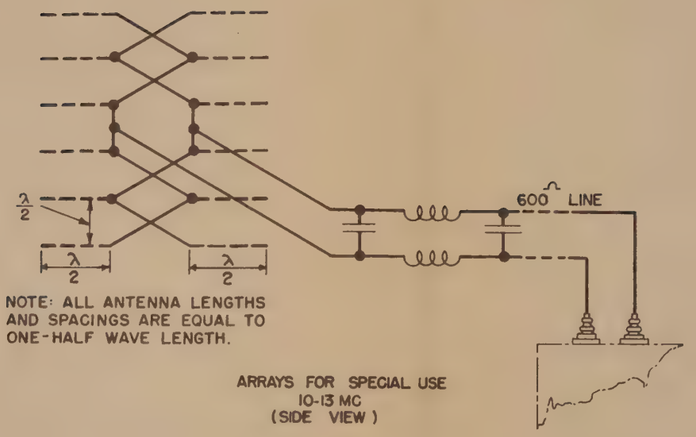
HORIZONTAL DOUBLET
3-13 MC
(SIDE VIEW)



RHOMBIC
6-13 MC
(PLAN VIEW)

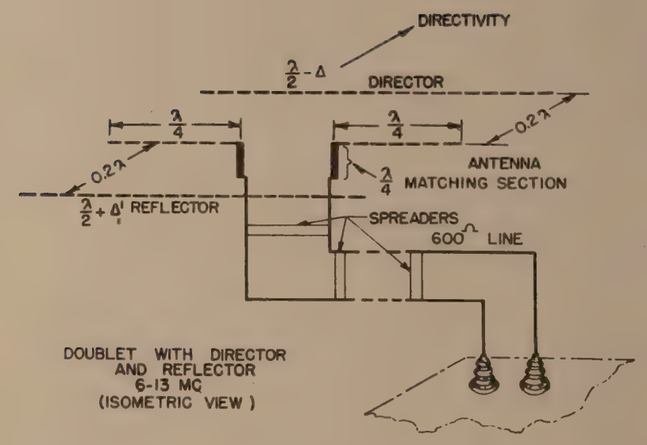


INVERTED V 6-13MC
(SIDE VIEW)

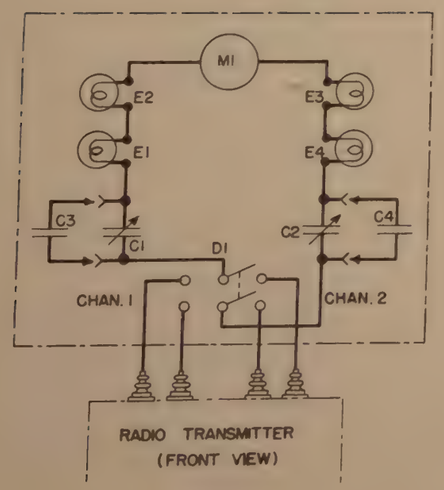


NOTE: ALL ANTENNA LENGTHS AND SPACINGS ARE EQUAL TO ONE-HALF WAVE LENGTH.

ARRAYS FOR SPECIAL USE
10-13 MC
(SIDE VIEW)



DOUBLET WITH DIRECTOR AND REFLECTOR
6-13 MC
(ISOMETRIC VIEW)



ARTIFICIAL ANTENNA

NOTE:
FOR CARRIER FREQUENCIES BETWEEN 3.0 AND 4.0 MC, CONNECT C3, C4 IN PARALLEL WITH C1, C2.

APPARATUS LIST FOR ARTIFICIAL ANTENNA

SYMBOL	DESCRIPTION
C1, C2	VARIABLE AIR CAPACITOR 165 MMF, CARDWELL TYPE XT-220-PS, HAMMARLUND TYPE TC-220-L OR EQUAL.
C3, C4	500 MMF FIXED CAPACITOR CORNELL-DUBILIER TYPE 6 OR 15, SANGAMO TYPE F1 OR F2 OR EQUAL.
D1	D.P.D.T 15AMP. 250V. PORCELAIN BASE KNIFE SWITCH.
E1 TO E4	100W. 120V CARBON FILAMENT LAMPS, BASES REMOVED, OR OHMITE DUMMY ANTENNA RESISTORS MODEL D-100-100 (100Ω)
M1	0-1.5 AMP. R-F AMMETER.

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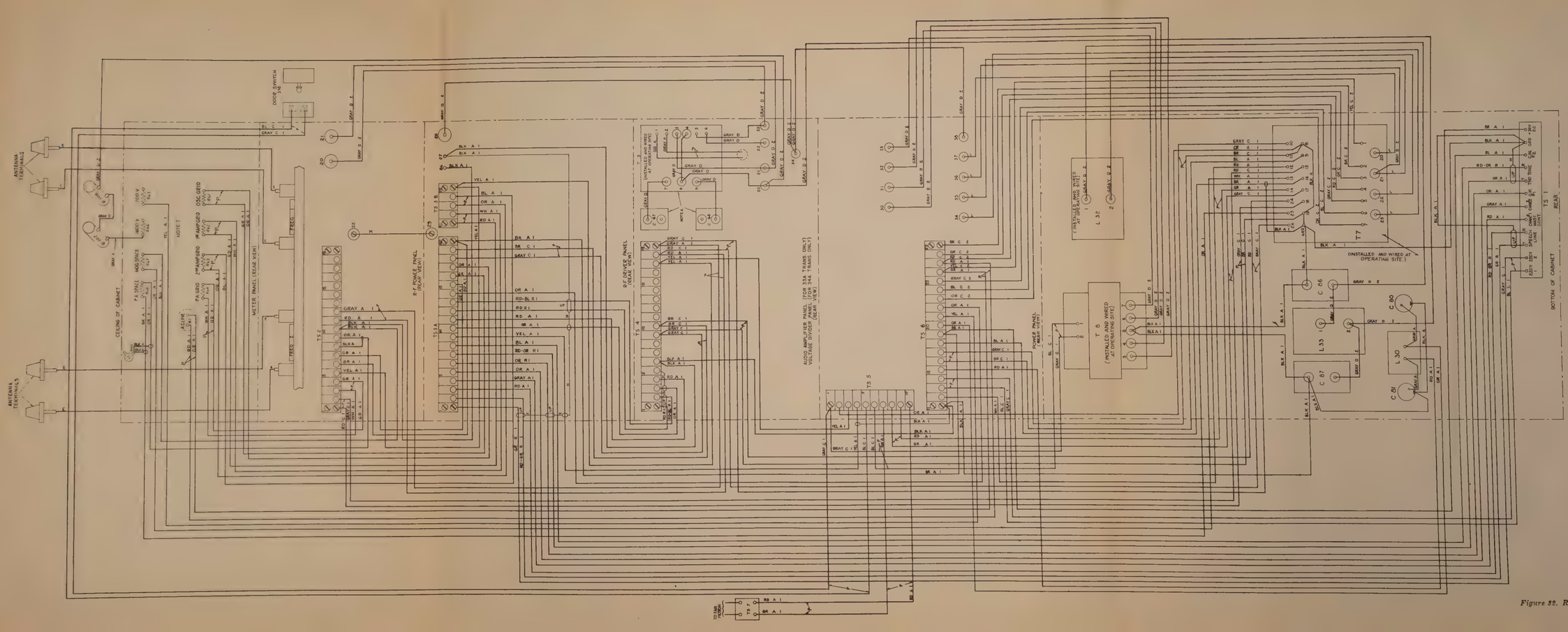
Figure 31. Types of antennas.


DOOR SWITCH 34
ANTENNA TERMINALS
CEILING OF CABINET
METER PANEL (REAR VIEW)
R.F. POWER PANEL (REAR VIEW)
R.F. DRIVER PANEL (REAR VIEW)
AUDIO AMPLIFIER PANEL (FOR 33A TRANS. ONLY) VOLTAGE DIVIDER PANEL (FOR 34A TRANS. ONLY) (REAR VIEW)
POWER PANEL (REAR VIEW)
(INSTALLED AND WIRED AT OPERATING SITE)
BOTTOM OF CABINET
REAR
NOTES:
1. "P" INDICATES TWISTED PAIR.
2. "JP" DENOTES SHIELDED PAIR.
3. "T" OR "L" DESIGNATES THE CABLE IN WHICH WIRES ARE RUN
4. TRANSFORMERS T7 AND T8 AND CHOKE L32 MUST BE MOUNTED IN PLACE AND WIRED AFTER THE TRANSMITTER HAS BEEN SET UP IN ITS FINAL LOCATION. RADIO TRANSMITTER 33A REQUIRES IN ADDITION, THE INSTALLATION OF TRANSFORMER T3 IN THE AUDIO AMPLIFIER PANEL.
5. THESE TRANSMITTERS ARE DESIGNED SO THAT ONE CAN BE CONVERTED TO THE OTHER BY THE INTERCHANGE OF THE AUDIO AMPLIFIER PANEL ON THE RADIO TRANSMITTER 33A WITH THE VOLTAGE DIVIDER PANEL ON THE RADIO TRANSMITTER 34A.
6. CAPACITORS C67,C68 AND TRANSFORMER T3 FORM A PART OF THE AUDIO AMPLIFIER PANEL OF THE RADIO TRANSMITTER 33A AND ARE NOT USED ON THE RADIO TRANSMITTER 34A.
7. RESISTORS R61 TO R68 INCLUSIVE, SHOWN IN DASHED LINES, ARE METER SHUNT RESISTORS MOUNTED ON THE METER PANEL.
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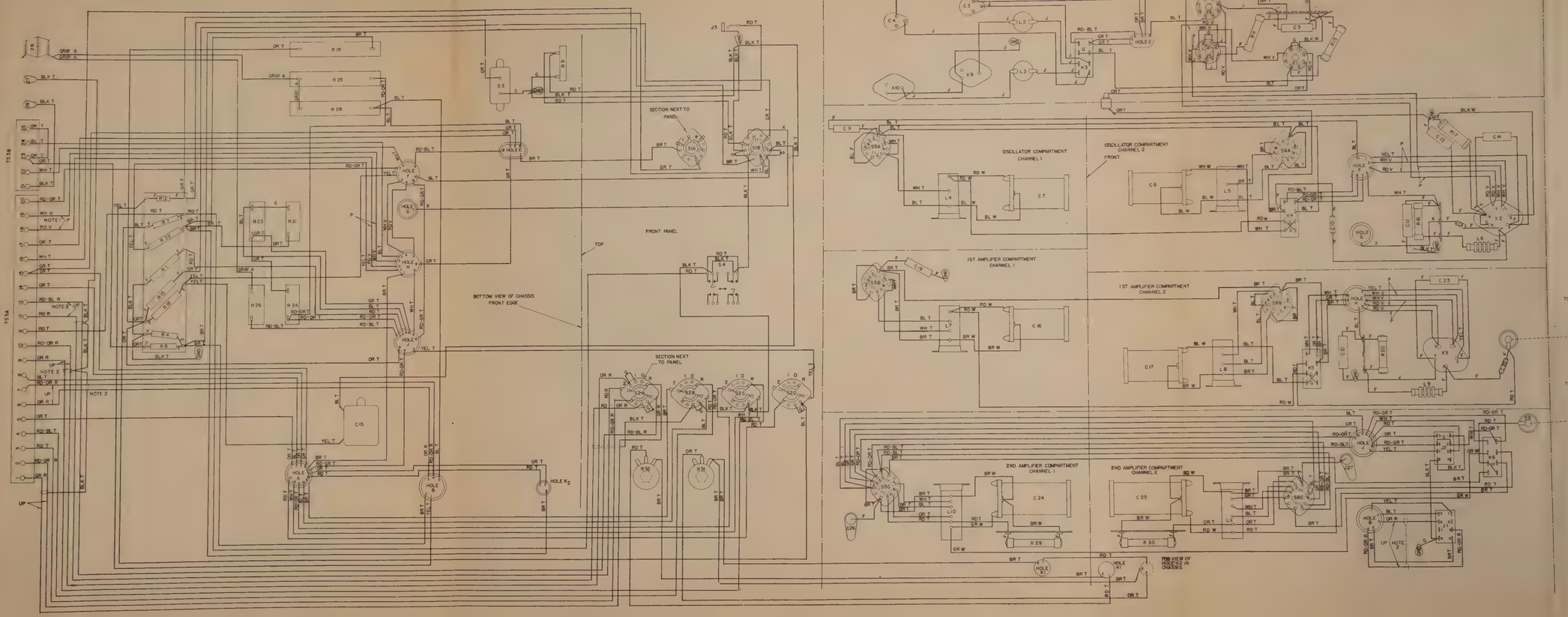
WIRES MARKED	DESCRIPTION
A	NO 18 A.W.G SOLID CONDUCTOR, DELTABESTON, FLAMENOL ASBESTOS SWITCHBOARD WIRE NO YK-4180.
C	NO 12 A.W.G. STRANDED CONDUCTOR, DELTABESTON, FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4280
D	NO 18 A.W.G. SOLID CONDUCTOR DELTABESTON SWITCHBOARD WIRE TYPE AVB, SIMILAR TO TABLE YK-416, EXCEPT TO HAVE DOUBLE THICKNESS OF VARNISHED CAMBRIC FOR WORKING VOLTAGE OF 3,000 V
E	1-1/4" O.D. X .035" WALL SOFT COPPER TUBING
H	NO 18 A.W.G BARE TINNED COPPER
L	1/2" WIDE X 1/16" THICK COPPER STRIP
M	NO 14 A.W.G. BELDEN COPPER CABLE, 168 STRANDS NO 36 BARE WIRE WITH TWO NO 199 ZIERICK TERMINALS, #16 DIA. HOLE, AND EIGHT NO 1084 ISOLANTITE BEADS IMPREGNATED FOR TROPICAL USE.
R	NO 18 A.W.G STRANDED CONDUCTOR MOISTURE-PROOF, FLAME RESISTANT ROCKBESTOS AGA WIRE OR APPROVED EQUIVALENT.

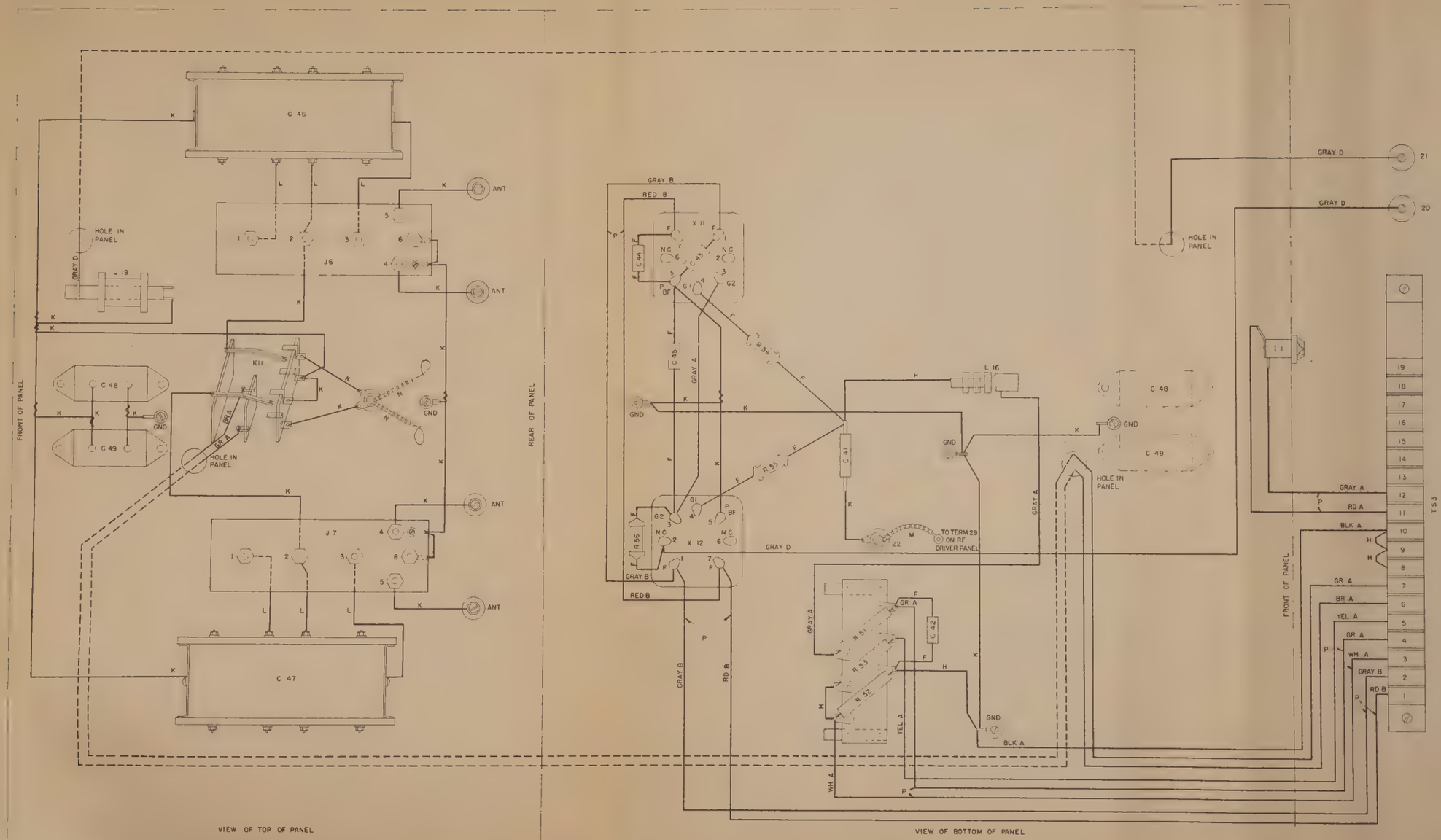
Figure 32. Radio Transmitters 33A and 34A, wiring diagram.



WIRES MARKED	DESCRIPTION
A	NO 18 AWG SOLID CONDUCTOR, DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. 9K-4180.
F	FURNISHED WITH APPARATUS.
G	NO 20 A.W.G. BARE TINNED COPPER.
J	NO 18 A.W.G. BARE TINNED COPPER.
R	NO 18 A.W.G. STRANDED CONDUCTOR, MOISTURE-PROOF, FLAME RESISTANT, ROCKBESTOS AGA WIRE OR EQUIVALENT.
T	NO 20 A.W.G. SOLID CONDUCTOR, MOISTURE-PROOF, FLAME RESISTANT, ROCKBESTOS AGA WIRE OR EQUIVALENT.
V	NO 18 A.W.G. STRANDED CONDUCTOR, MOISTURE-PROOF, FLAME RESISTANT, ROCKBESTOS AGA WIRE OR EQUIVALENT.
W	NO 18 A.W.G. SOLID CONDUCTOR, MOISTURE-PROOF, FLAME RESISTANT, ROCBESTOS AGA WIRE OR EQUIVALENT.
X	KS-8086 SHIELDED CABLE.

NOTES
1 "P" INDICATES TWISTED PAIR
2 "UP" DENOTES SHIELD PAIR

Figure 33. R-f driver panel, wiring diagram.



NOTES

1. "P" INDICATES TWISTED PAIR
2. CIRCUIT SYMBOLS SHOWN ON APPARATUS AND TERMINAL NUMBERS AND LETTERS ON TUBE SOCKETS ARE FOR REFERENCE PURPOSES AND DO NOT APPEAR ON THE EQUIPMENT

WIRES MARKED	DESCRIPTION
A	NO. 18 AWG SOLID CONDUCTOR, DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4180
B	NO. 14 AWG STRANDED CONDUCTOR, DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4280
D	NO. 18 AWG SOLID CONDUCTOR, DELTABESTON SWITCHBOARD WIRE TYPE AVB SIMILAR TO TABLE YK-4161 EXCEPT TO HAVE DOUBLE THICKNESS OF VARNISHED CAMBRIC FOR WORKING VOLTAGE OF 3000V
F	FURNISHED WITH APPARATUS.
H	NO. 18 AWG BARE TINNED COPPER.
K	NO. 12 AWG BARE TINNED COPPER.
L	3/4 WIDE BY .010" THICK COPPER STRIP WITH SILVER PLATE FINISH.
M	NO. 14 AWG BELDEN COPPER CABLE, 168 STRANDS NO. 36 BARE WIRE, EQUIPPED WITH TWO NO. 189 ZIERICK TERMINALS, .196 DIA. HOLE, AND 8 NO. 1084 ISOLANTITE BEADS IMPREGNATED FOR TROPICAL USE.
N	NO. 14 AWG BELDEN COPPER CABLE, 168 STRANDS NO. 36 BARE WIRE, EQUIPPED WITH NO. 24 NATIONAL GRID GRIP (MEDIUM) AND 19 NO. 1084 ISOLANTITE BEADS IMPREGNATED FOR TROPICAL USE.

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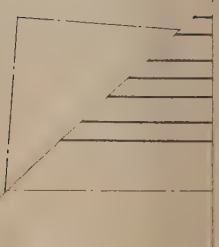
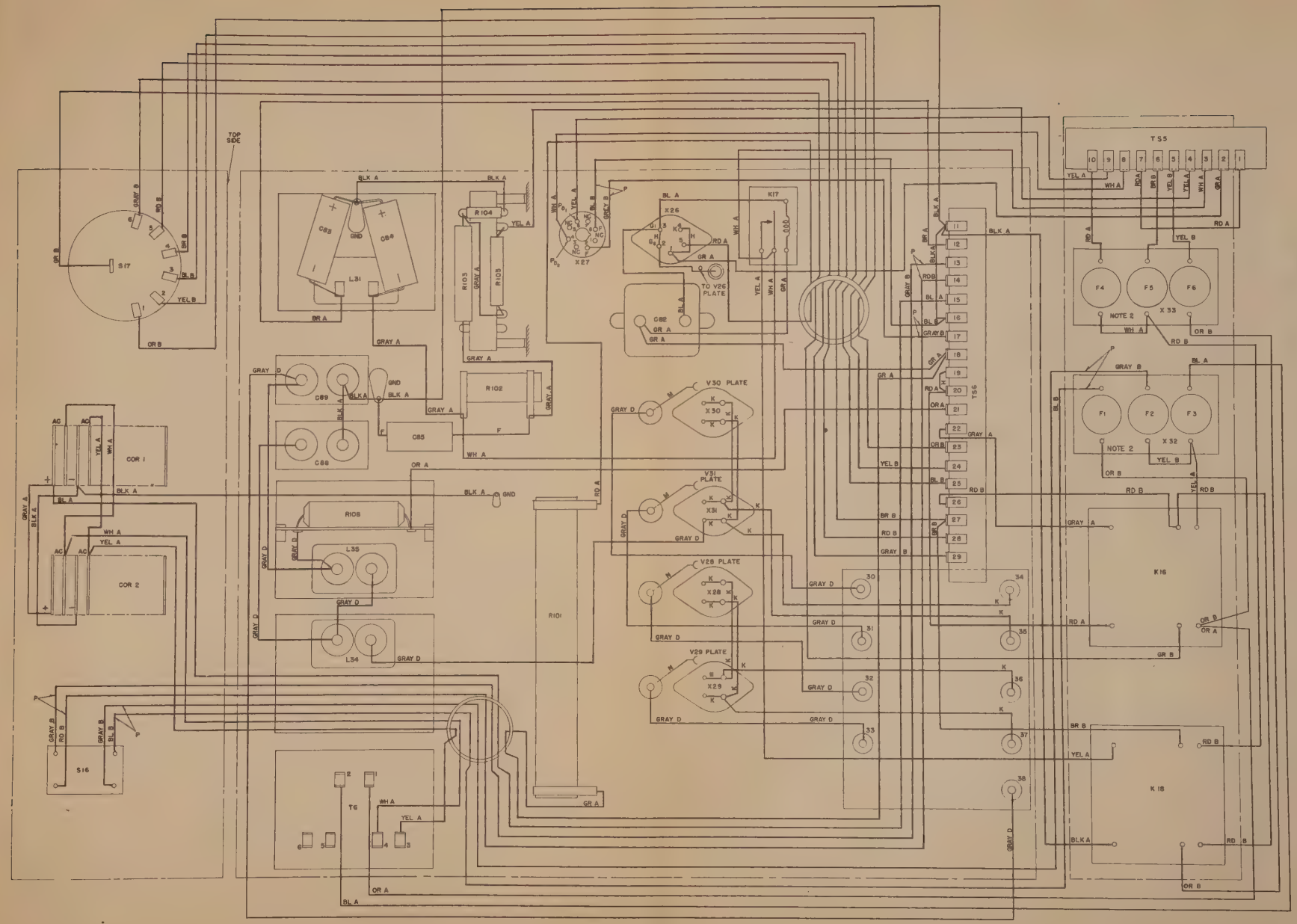
Figure 34. R-f power amplifier panel, wiring diagram.





WIRES MARKED	DESCRIPTION
A	NO 18 AWG SOLID CONDUCTOR, DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4180
B	NO 14 AWG STRANDED CONDUCTOR, DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO YK-4280
D	NO 18 AWG SOLID CONDUCTOR, DELTABESTON SWITCHBOARD WIRE TYPE AVB SIMILAR TO TABLE YK-4161 EXCEPT TO HAVE DOUBLE THICKNESS OF VARNISHED CAMBRIC FOR WORKING VOLTAGE OF 3000 V
F	FURNISHED WITH APPARATUS
H	NO 18 AWG BARE TINNED COPPER
K	NO 12 AWG BARE TINNED COPPER
M	NO. 14 A.W.G. BELDEN COPPER CABLE, 168 STRANDS NO 36 BARE WIRE EQUIPPED WITH NO. 189 ZIERICK TERMINAL, 196 DIA. HOLE, NO 12 NATIONAL GRID GRIP (LARGE) AND 25 NO 1084 ISOLANTITE BEADS IMPREGNATED FOR TROPICAL USE
N	NO 14 A.W.G. BELDEN COPPER CABLE, 168 STRANDS NO 36 BARE WIRE, EQUIPPED WITH NO 189 ZIERICK TERMINAL, 196 DIA. HOLE NO 24 NATIONAL GRID GRIP (MEDIUM) AND 25 NO. 1084 ISOLANTITE BEADS IMPREGNATED FOR TROPICAL USE.
O	NO 16 A.W.G. STRANDED CONDUCTOR PER KS-8640, WITH NO 24 NATIONAL GRID GRIP (MEDIUM) AND 7/64" I.D. X 3/64" THICK WALL X 1/2" LONG GUM RUBBER TUBING

NOTES:

1. "P" INDICATES TWISTED PAIR.
2. CIRCUIT SYMBOLS SHOWN ON APPARATUS ARE FOR REFERENCE ONLY AND DO NOT APPEAR ON THE EQUIPMENT. HOWEVER, FUSE DESIGNATIONS, RATINGS AND CIRCUITS IN WHICH THEY ARE USED ARE SHOWN ADJACENT TO FUSES ON THE FUSE BLOCKS.

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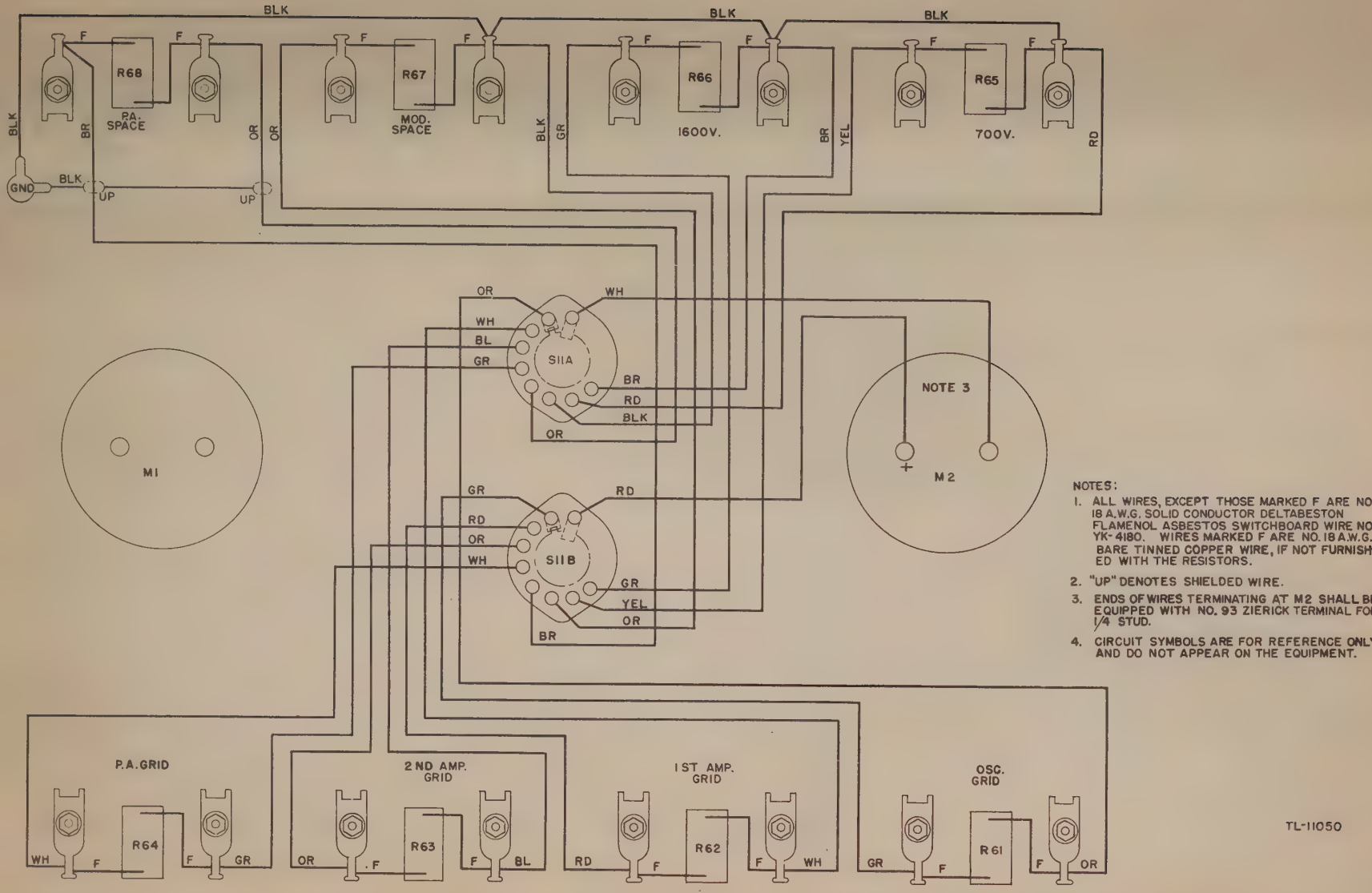
Figure 35. Power panel, wiring diagram.



NOTES:

1. ALL WIRES, EXCEPT THOSE MARKED F ARE NO. 18 A.W.G. SOLID CONDUCTOR DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4180. WIRES MARKED F ARE NO. 18 A.W.G. BARE TINNED COPPER WIRE, IF NOT FURNISHED WITH THE RESISTORS.
2. "UP" DENOTES SHIELDED WIRE.
3. ENDS OF WIRES TERMINATING AT M2 SHALL BE EQUIPPED WITH NO. 93 ZIERICK TERMINAL FOR 1/4 STUD.
4. CIRCUIT SYMBOLS ARE FOR REFERENCE ONLY AND DO NOT APPEAR ON THE EQUIPMENT.

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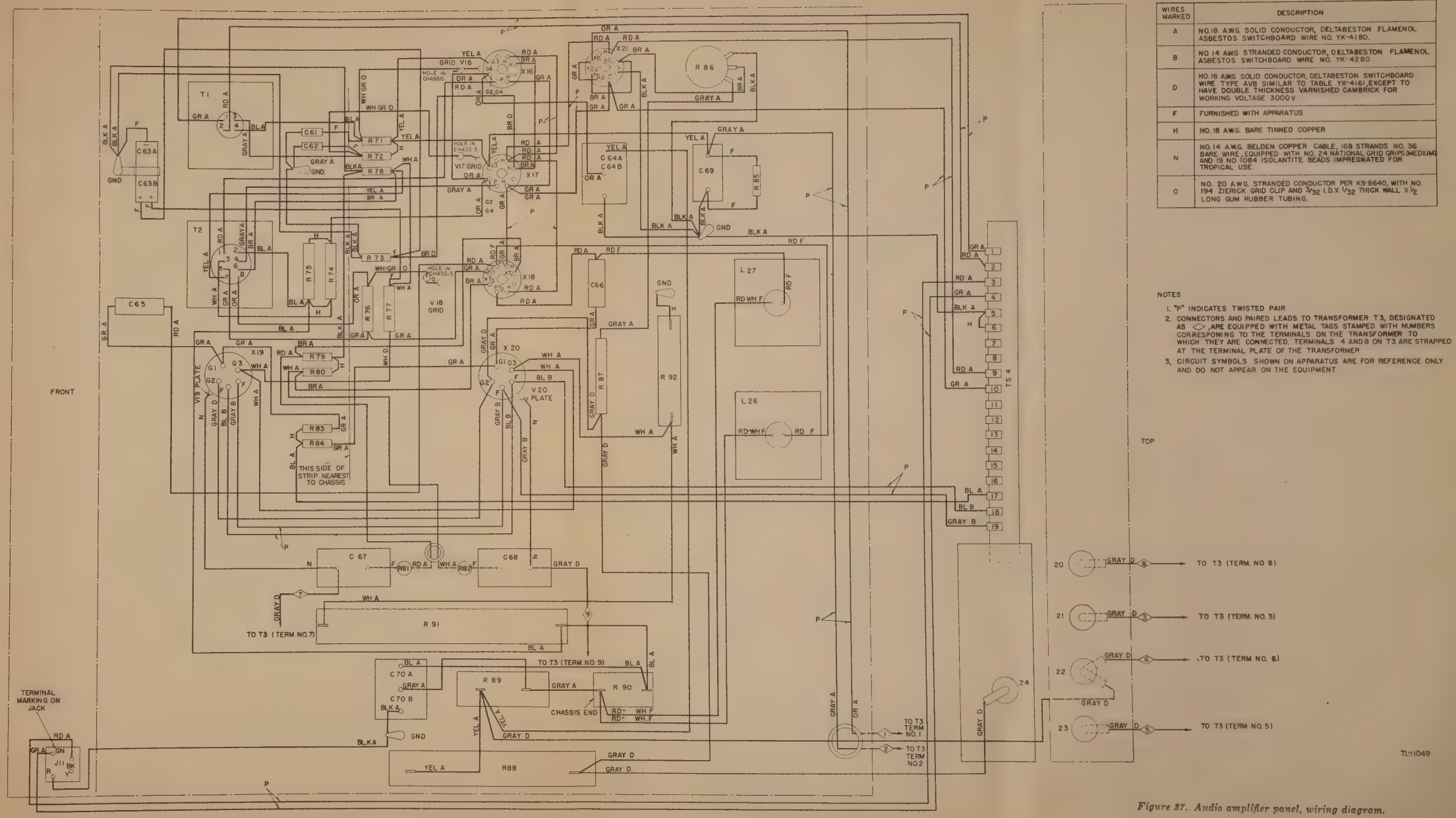
Figure 36. Meter panel, wiring diagram.



WIRES MARKED	DESCRIPTION
A	NO.18 A.W.G. SOLID CONDUCTOR, DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4180.
B	NO 14 AWG STRANDED CONDUCTOR, DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4280
D	NO.18 AWG SOLID CONDUCTOR, DELTABESTON SWITCHBOARD WIRE TYPE AVB SIMILAR TO TABLE YK-4161, EXCEPT TO HAVE DOUBLE THICKNESS VARNISHED CAMBRICK FOR WORKING VOLTAGE 3000 V
F	FURNISHED WITH APPARATUS
H	NO. 18 A.W.G. BARE TINNED COPPER
N	NO 14 A.W.G. BELDEN COPPER CABLE, 168 STRANDS NO. 36 BARE WIRE, EQUIPPED WITH NO. 24 NATIONAL GRID GRIPS (MEDIUM) AND 19 NO 1084 ISOLANTITE BEADS IMPREGNATED FOR TROPICAL USE.
O	NO. 20 A.W.G. STRANDED CONDUCTOR PER KS-8640, WITH NO. 194 ZIERICK GRID CLIP AND $\frac{3}{32}$ I.D. X $\frac{1}{32}$ THICK WALL X $\frac{1}{2}$ LONG GUM RUBBER TUBING.

NOTES

1. "P" INDICATES TWISTED PAIR
2. CONNECTORS AND PAIRED LEADS TO TRANSFORMER T3, DESIGNATED AS ◇, ARE EQUIPPED WITH METAL TAGS STAMPED WITH NUMBERS CORRESPONING TO THE TERMINALS ON THE TRANSFORMER TO WHICH THEY ARE CONNECTED. TERMINALS 4 AND 8 ON T3 ARE STRAPPED AT THE TERMINAL PLATE OF THE TRANSFORMER
3. CIRCUIT SYMBOLS SHOWN ON APPARATUS ARE FOR REFERENCE ONLY AND DO NOT APPEAR ON THE EQUIPMENT

Figure 37. Audio amplifier panel, wiring diagram.

WIRES MARKED	DESCRIPTION
A	NO.18 A.W.G SOLID CONDUCTOR DELTABESTON FLAMENOL ASBESTOS SWITCHBOARD WIRE NO. YK-4180
D	NO. 18 A.W.K. SOLID CONDUCTOR, DELTABESTON SWITCHBOARD WIRE TYPE AVB, SIMILAR TO TABLE YK-4161, EXCEPT TO HAVE DOUBLE THICKNESS OF VARNISHED CAMBRIC FOR WORKING VOLTAGE OF 3000 V.
H	NO.18 A.W.G. BARE TINNED COPPER

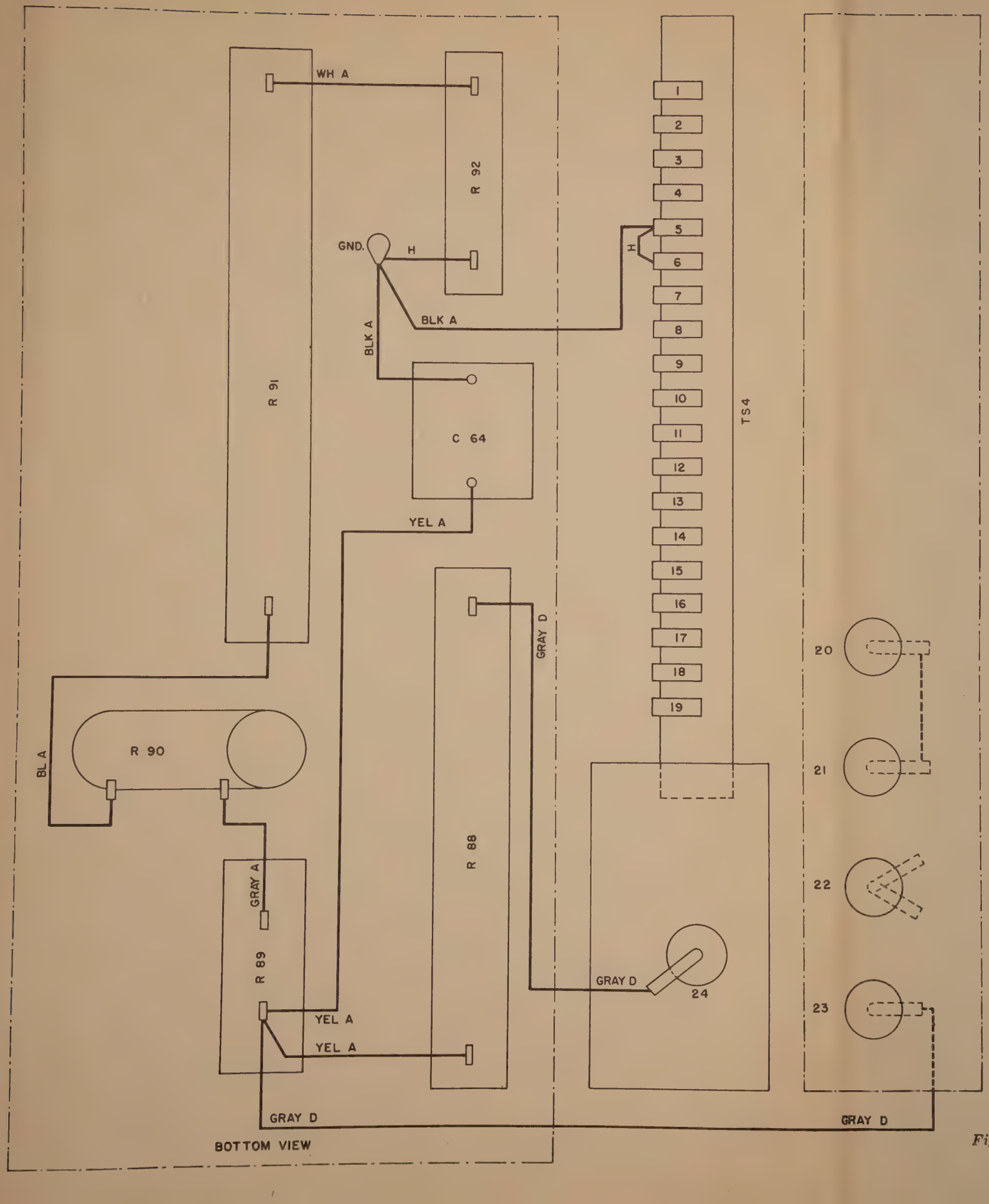


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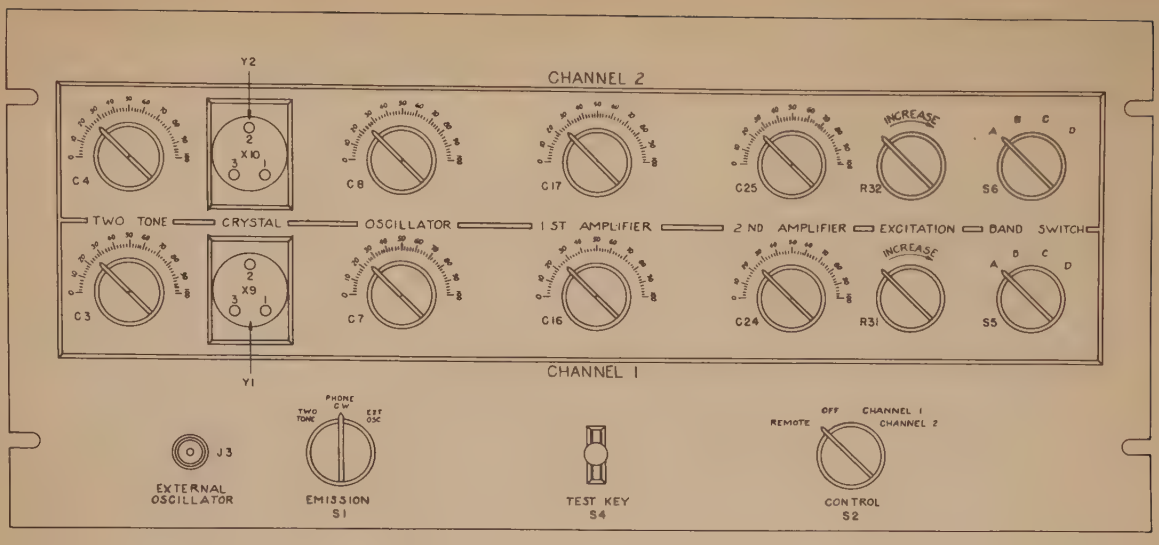
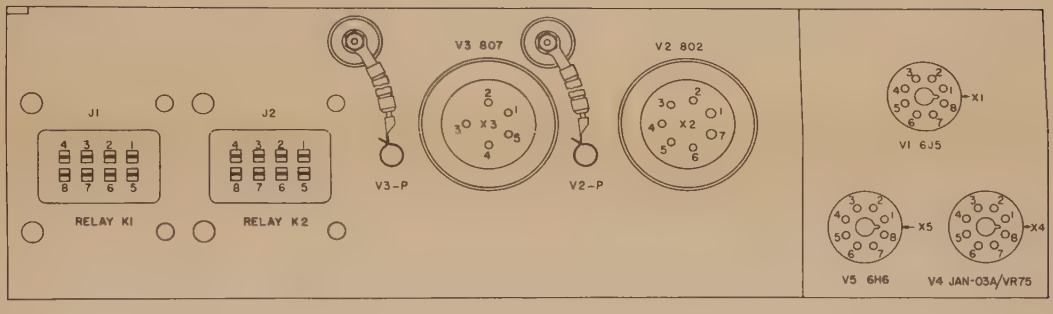
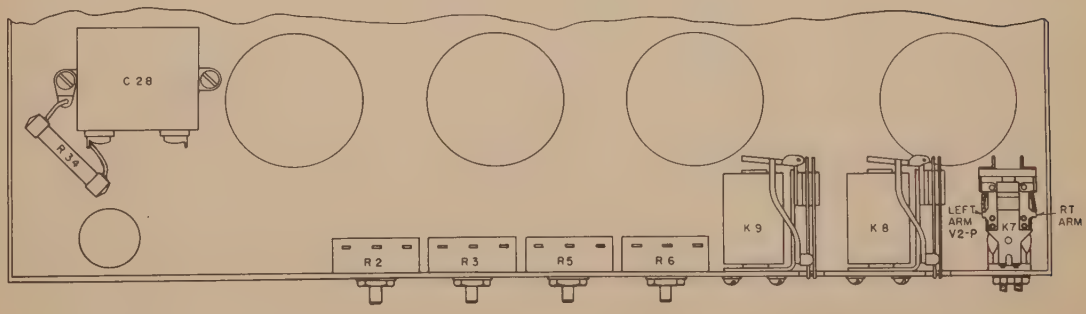
Figure 38. Voltage divider panel, wiring diagram.



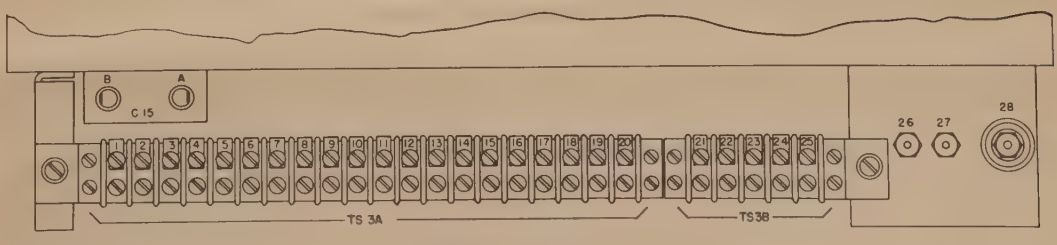
FRONT PANEL



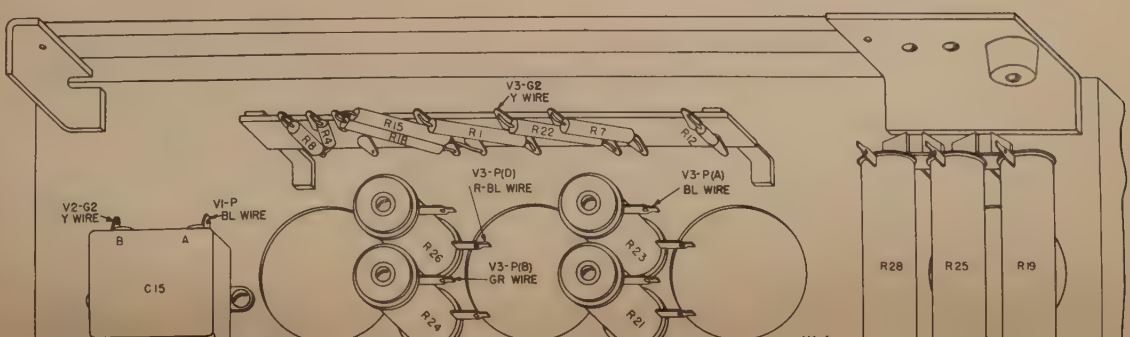
REAR PANEL

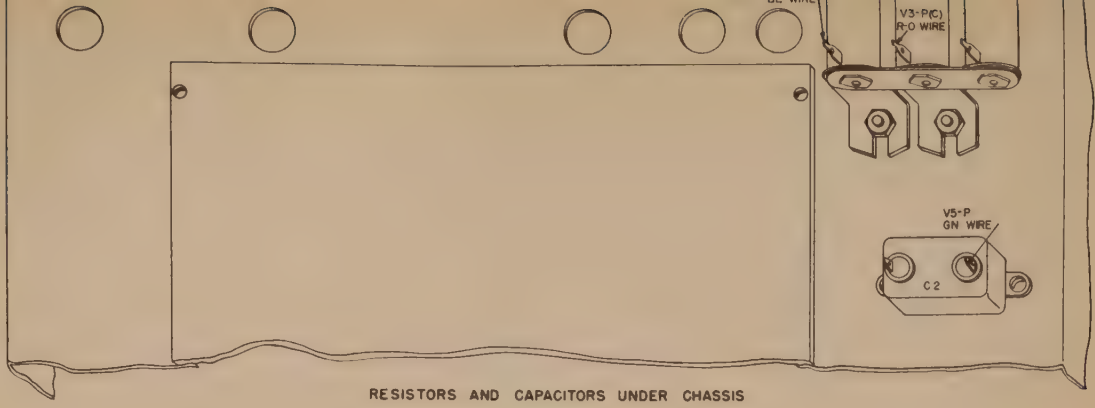


TOP VIEW OF REAR OF CHASSIS



TERMINAL STRIP





RESISTORS AND CAPACITORS UNDER CHASSIS

OPERATING VOLTAGES – DRIVER PANEL

GRID AND PLATE VOLTAGES – SEE NOTES 1,2,3 & 4

TUBE	ELEMENT	TEST POINT APPARATUS	TEST POINT TERMINAL	METER SCALE	VOLTAGE BAND SW. POSITION A	B	C	D	REMARKS
V1 OSC.	P	C15A	BL. WIRE	250	90	95	100	130	
V2 1ST AMP.	G2	C15B	Y. WIRE	250	105	105	110	150	
V2 1ST AMP.	P	K7	LT. ARM.	250	240	-	-	-	EXCITATION CONTROL AT 135°.
V2 1ST AMP.	P	K7	LT. ARM.	250	230	230	235	-	EXCITATION CONTROL AT 0°.
V2 1ST AMP.	P	K7	LT. ARM.	500	-	-	-	295	EXCITATION CONTROL AT 135°.
V3 2ND AMP.	G1	DRIVER PAN.	#25	250	-110	-110	-110	-110	
V3 2ND AMP.	G2	R22	Y. WIRE	250	200	205	225	-	
V3 2ND AMP.	G2	R22	Y. WIRE	500	-	-	-	295	
V3 2ND AMP.	P	R23	BL. WIRE	500	370	-	-	-	
V3 2ND AMP.	P	R24	GR. WIRE	500	-	370	-	-	
V3 2ND AMP.	P	R25	R-O. WIRE	500	-	-	420	-	
V3 2ND AMP.	P	R26	R-BL. WIRE	500	-	-	-	425	
V4 VOLT. REG.	ANODE	R28	BL. WIRE	100	75	75	75	75	
V5 DIODE RECT.	P	C2	GR. WIRE	100	-55	-55	-55	-55	TWO-TONE MARKING SIGNAL.
V5 DIODE RECT.	P	C2	GR. WIRE	100	68	68	68	68	TWO-TONE SPACING SIGNAL.

HEATER VOLTAGES – SEE NOTE 5

TUBE	ELEMENT	TEST POINT APPARATUS	TEST POINT TERMINAL	METER SCALE	VOLTAGE	REMARKS
V1 OSC.	H	X1	#2	10	6.4 AC	6J5 - PLATE POWER OFF
V1 OSC.	H	X1	#7	10	0	6J5 - PLATE POWER OFF.
V2 1ST AMP.	H	X2	#1	10	0	802 - PLATE POWER OFF.
V2 1ST AMP.	H	X2	#7	10	6.4 AC	802 - PLATE POWER OFF.
V3 2ND AMP.	H	X3	#1	10	0	807 - PLATE POWER OFF.
V3 2ND AMP.	H	X3	#5	10	6.4 AC	807 - PLATE POWER OFF.
V5 DIODE RECT.	H	X5	#2	10	6.4 AC	6H6 - PLATE POWER OFF.
V5 DIODE RECT.	H	X5	#7	10	0	6H6 - PLATE POWER OFF.

TERMINAL STRIP VOLTAGES

TEST POINT APPARATUS	TEST POINT TERMINAL	METER SCALE	VOLTAGE	REMARKS
TS3A	1	1.	0	SEE NOTE 6.
TS3A	2	1.	0	SEE NOTE 6.
TS3A	3	50.	40	SWITCH S2 ON REMOTE & S16-ON, TRANSMITTER IS OFF, SEE NOTE 6.
TS3A	4	50.	40	SWITCH S2 ON REMOTE & S16-ON, TRANSMITTER IS OFF, SEE NOTE 6.
TS3A	5	50.	40	SWITCH S2 ON REMOTE & S16-ON, TRANSMITTER IS OFF, SEE NOTE 6.
TS3A	6	1.	0	SEE NOTE 6.
TS3A	7	1.	0	SEE NOTE 6.
TS3A	8	50.	40	SWITCHES S2 ON REMOTE & S16-ON, TRANSMITTER IS OFF, SEE NOTE 6.
TS3A	9	5.	-3	
TS3A	10	5.	-3	HANDSET BUTTON NORMAL.
TS3A	10	5.	-1	HANDSET BUTTON OPERATED.
TS3A	11	50.	35	TEST KEY S4 NORMAL, CARRIER IS OFF, SWITCH S2 ON CHANNEL #1.
TS3A	12	5.	-3	
TS3A	13	5.	-3	
TS3A	14	25	16	
TS3A	15	50	35	
TS3A	16	1.	0	SWITCH S1 ON PHONE-CW.
TS3A	17	1.	0	SWITCH S1 ON PHONE-CW - VOLTAGE NOT READABLE.
TS3A	18	10.	6.4 AC	
TS3A	19	1.	0	
TS3A	20	50	35	
TS3B	21	1.	0	
TS3B	22	1.	0	VOLTAGE NOT READABLE.
TS3B	23	250	-110	
TS3B	24	250	-110	
TS3B	25	250	-110	
	28	1000	700	

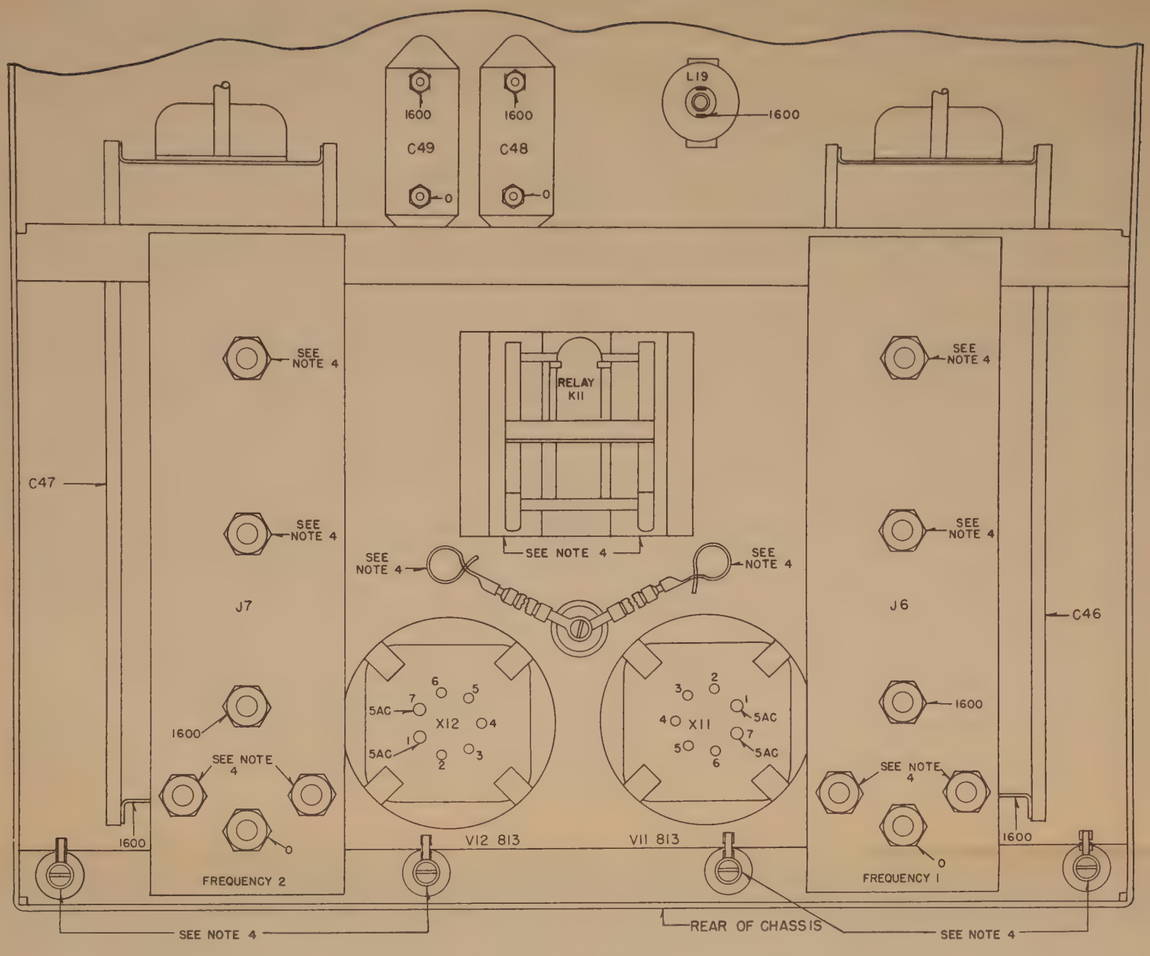
MISCELLANEOUS VOLTAGE POINTS

JACK J1	1	1.	0	RELAY K1 REMOVED FROM JACK.
JACK J1	2	1.	0	RELAY K1 REMOVED FROM JACK.
JACK J1	3	1.	0	RELAY K1 REMOVED FROM JACK, SEE NOTE 6.
JACK J1	4	100	-55	RELAY K1 REMOVED FROM JACK.
JACK J1	5	100	75	RELAY K1 REMOVED FROM JACK.
JACK J1	6	1.	0	RELAY K1 REMOVED FROM JACK, SEE NOTE 6.
JACK J1	7	1.	0	RELAY K1 REMOVED FROM JACK.
JACK J1	8	1.	0	RELAY K1 REMOVED FROM JACK.
JACK J2	1	1.	0	RELAY K2 REMOVED FROM JACK.
JACK J2	2	50	35	RELAY K2 REMOVED FROM JACK.
JACK J2	3	1.	0	RELAY K2 REMOVED FROM JACK.
JACK J2	4	1.	0	RELAY K2 REMOVED FROM JACK.
JACK J2	5	250	150	RELAY K2 REMOVED FROM JACK, FULL POWER CARRIER ON BAND "A".
JACK J2	6	50	35	RELAY K2 REMOVED FROM JACK,
JACK J2	7	1.	0	RELAY K2 REMOVED FROM JACK.
JACK J2	8	1.	0	RELAY K2 REMOVED FROM JACK.
JACK J3	TIP	1.	0	

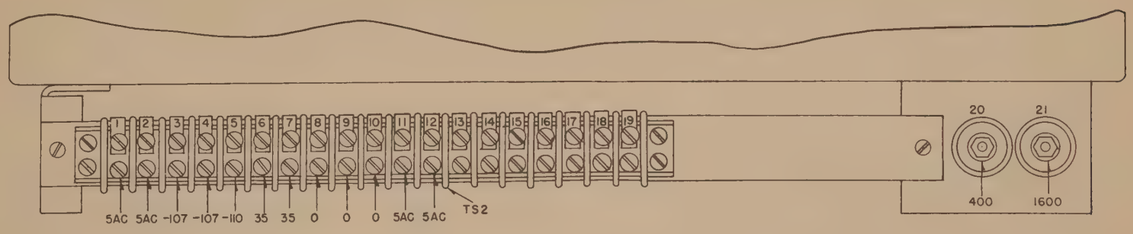
NOTES:
1. ALL VOLTAGES ARE POSITIVE UNLESS OTHERWISE DESIGNATED.
2. ALL VOLTAGE TESTS MADE WITH ANALYZER OF TEST SET I-56-A FROM TEST POINT TO GROUND TERMINAL.
3. ALL VOLTAGE TESTS MADE WHILE TRANSMITTER IS ON WITH FULL POWER OUTPUT ON CHANNEL #1 UNDER LOCAL CONTROL UNLESS OTHERWISE INDICATED.
4. ACTUAL VOLTAGE AT V5 PLATES WILL BE LESS THAN VALUE SHOWN BY VOLTAGE DROP IN R11.
5. HEATER VOLTAGES ARE MEASURED AT SOCKET TERMINALS WITH TUBE OUT OF SOCKET AND REAR DOOR OPEN.
6. THE CONTROL LINE WIRES SHALL BE REMOVED FROM THE CORRESPONDING TERMINALS ON MAIN TERMINAL STRIP TS1 WHEN CHECKING VOLTAGES AT DRIVER PANEL TERMINALS #1 TO 8 INCLUSIVE AND JACK J1 TERMINALS #3 & 6.

Figure 89. Driver panel, voltage diagram.

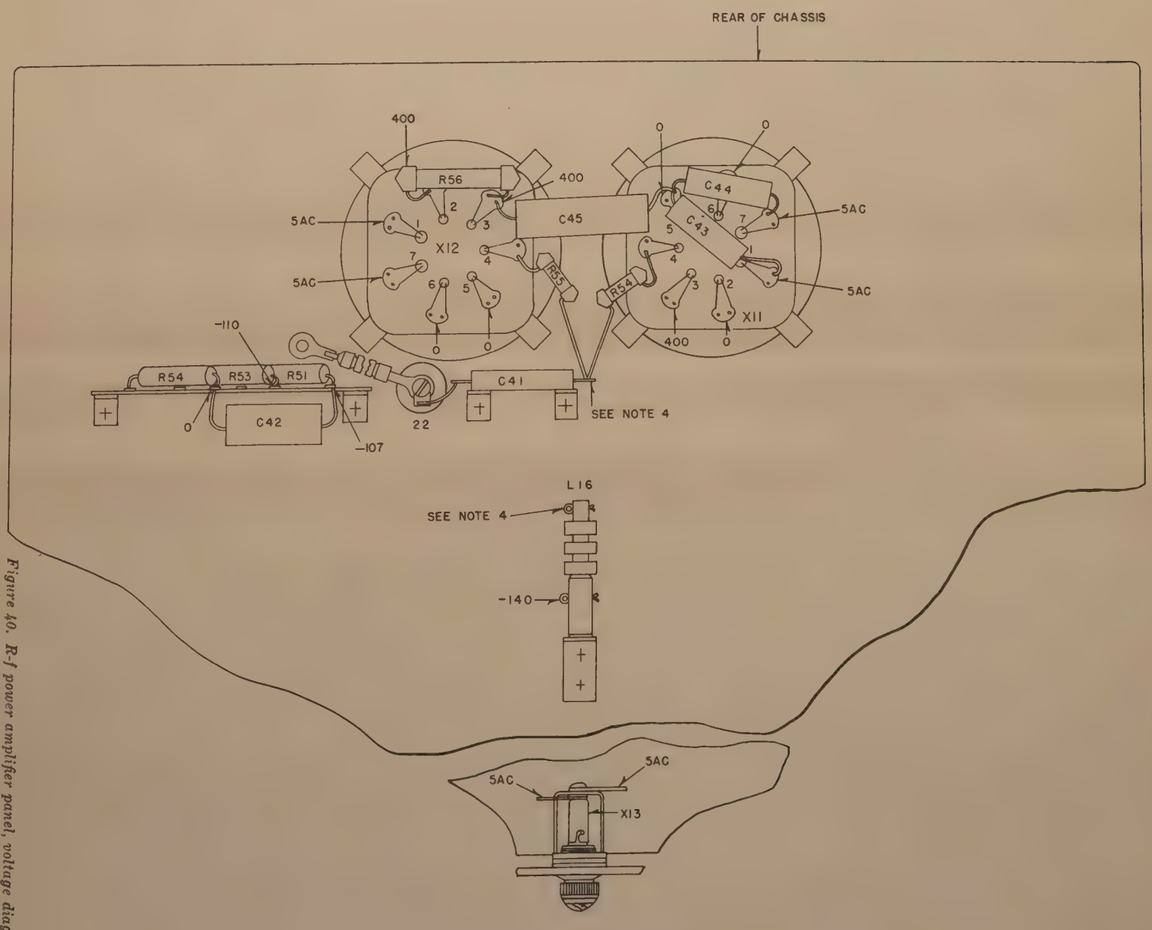
TL-I5562



TOP VIEW OF CHASSIS



TERMINAL STRIP

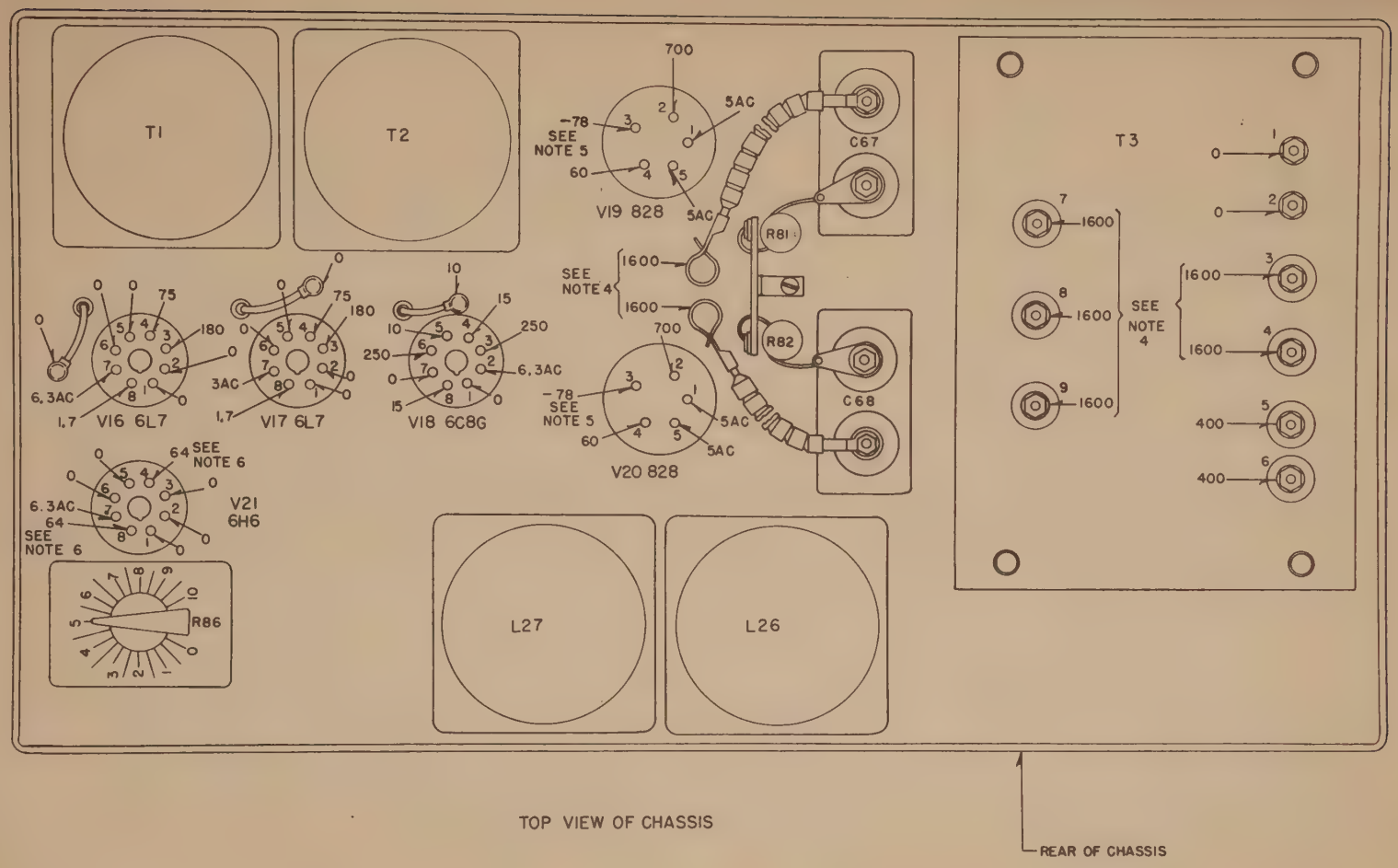


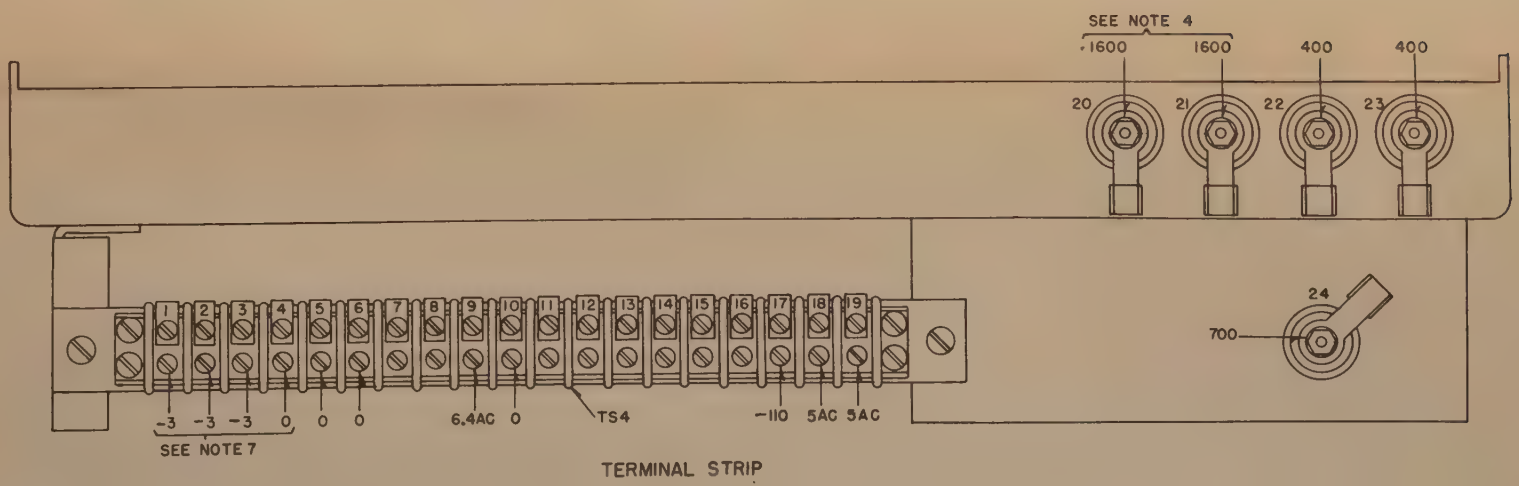
BOTTOM VIEW OF CHASSIS

Figure 40. R-f power amplifier panel, voltage diagram.

NOTES:

1. ALL VOLTAGES ARE POSITIVE UNLESS OTHERWISE INDICATED.
2. ALL TESTS MADE WITH ANALYZER OF TEST SET I-56-A FROM TEST POINT TO GROUND. USE HIGH VOLTAGE TEST CORD IN 1000 VOLT PIN JACK TO OBTAIN 2000 VOLT SCALE FOR 1600 VOLT POINTS.
3. ALL VOLTAGE TESTS, EXCEPT FILAMENT VOLTAGES, ARE MADE WHILE TRANSMITTER IS ON WITH FULL POWER OUTPUT ON CHANNEL NO. 1. CHECK FILAMENT VOLTAGES WITH TUBE OUT OF SOCKET AND REAR DOOR OPEN.
4. DO NOT CONNECT ANY TEST METER TO HIGH VOLTAGE R.F. TERMINALS WHILE CARRIER IS ON.

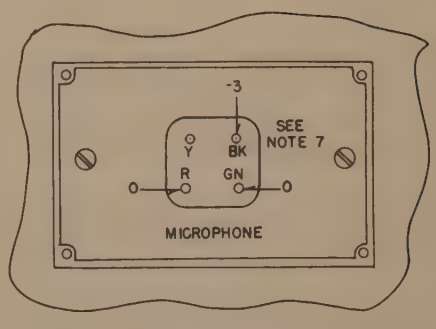




TERMINAL STRIP

NOTES

1. ALL VOLTAGES ARE POSITIVE UNLESS OTHERWISE INDICATED.
2. ALL VOLTAGES ARE MEASURED WITH TUBES IN SOCKETS (OR ADAPTER) WITH FULL POWER R.F. CARRIER OUTPUT AND NO AUDIO INPUT.
3. ALL VOLTAGE MEASUREMENTS MADE WITH ANALYZER OF TEST SET I-56-A USING METER SCALE NEXT HIGHER ABOVE VOLTAGE INDICATED. ALL READINGS ARE WITH RESPECT TO GRD. TERMINAL.
4. HIGH VOLTAGE TEST CORD USED IN 1000 VOLT PIN JACK TO OBTAIN 2000 VOLT SCALE FOR 1600 VOLT POINTS.
5. ACTUAL VOLTAGE ON V19 & V20 TERMINAL NO. 3 MAY BE MEASURED AT AUDIO PANEL TERMINAL NO. 17.
6. VOLTAGE SHOWN FOR V21 TERMINALS NO. 4 & 8 IS OBTAINED WITH R86 SET ON NO. 8.
7. SWITCH S2 ON CHANNEL NO. 1, TEST KEY S4 OPERATED AND HANDSET BUTTON NORMAL.



HANDSET JACK

Figure 41. Audio panel, voltage diagram.

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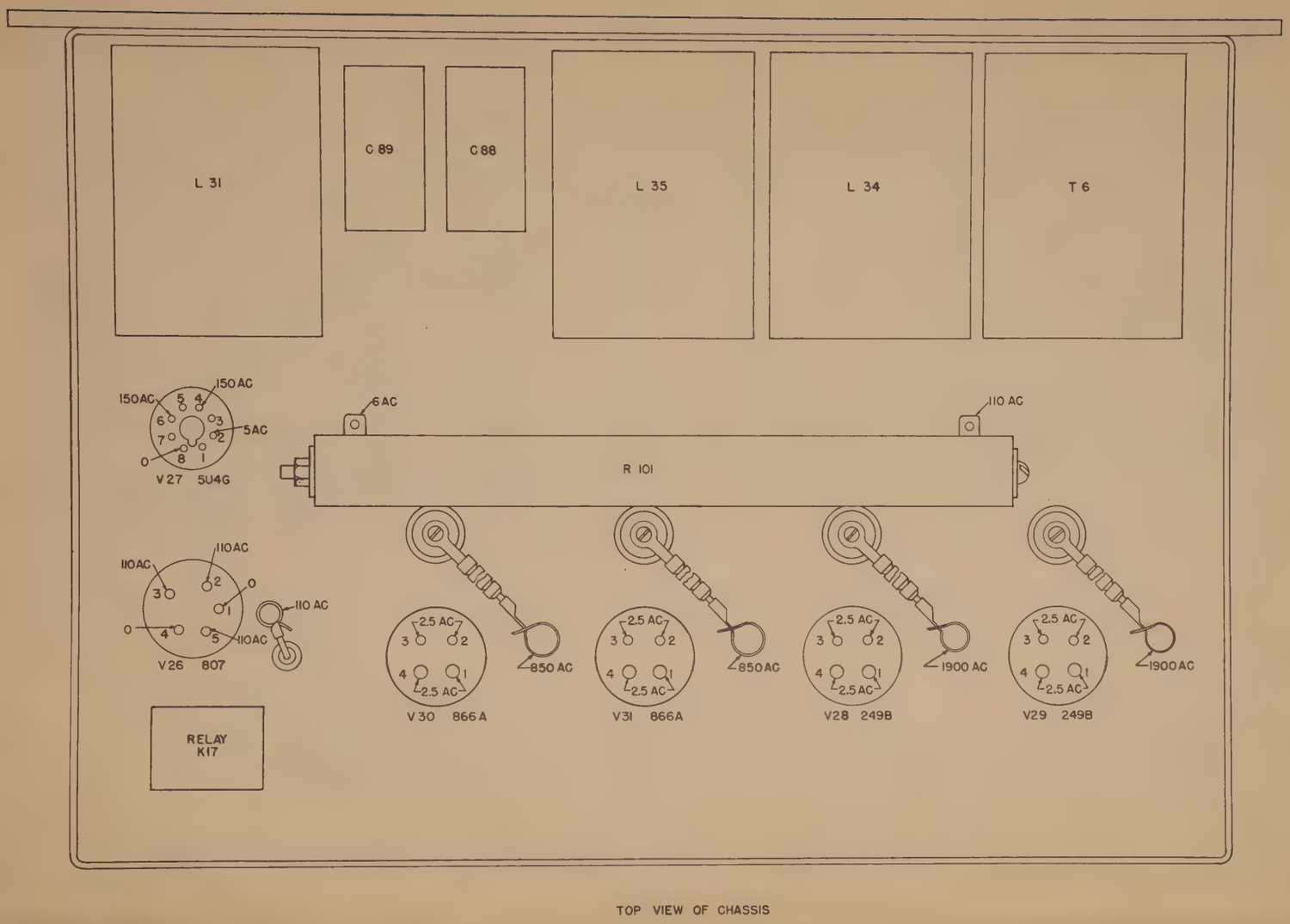
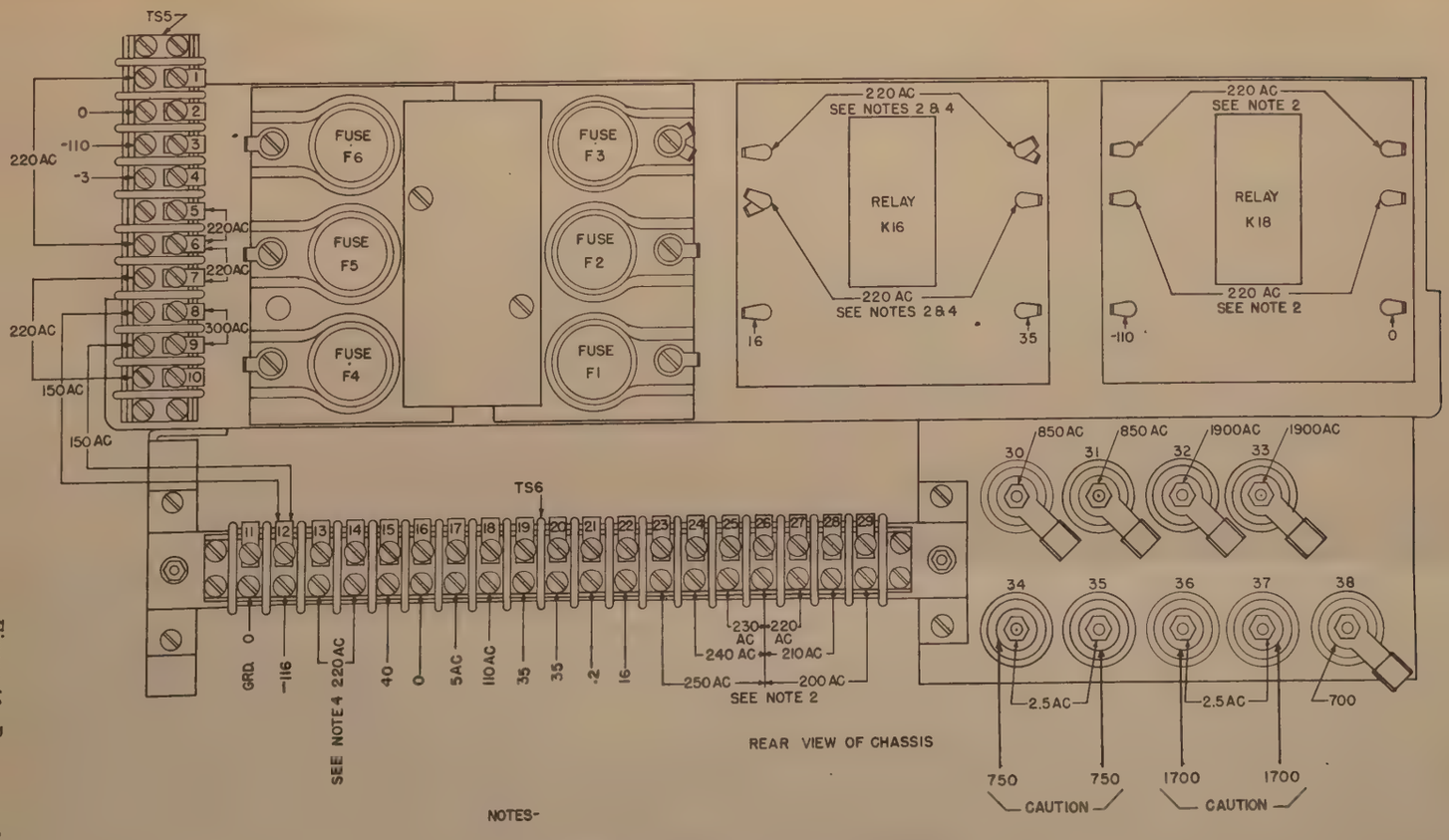


TOP VIEW OF CHASSIS

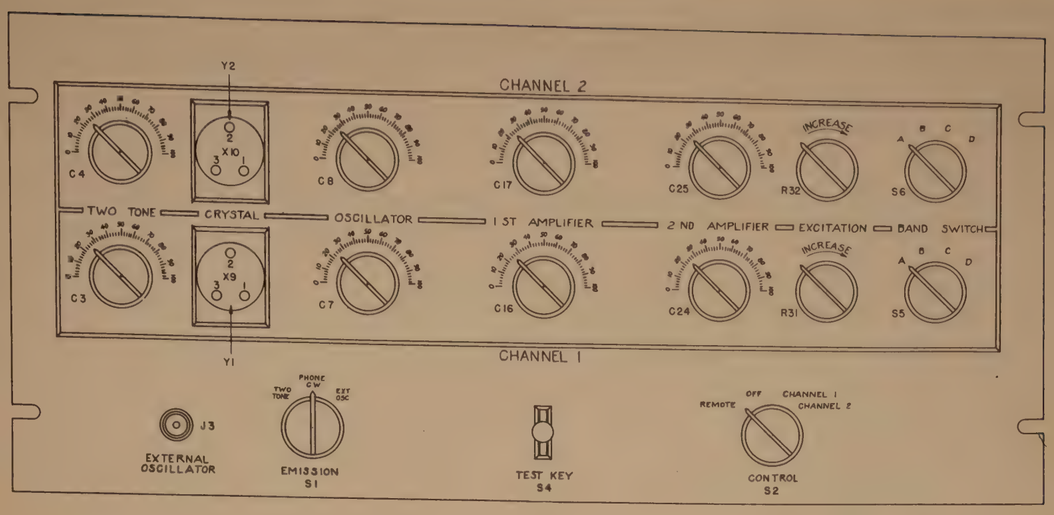


REAR VIEW OF CHASSIS

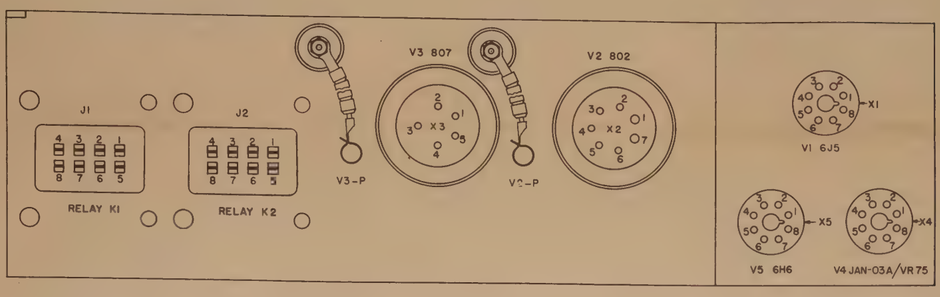
NOTES-

1. ALL VOLTAGES ARE POSITIVE UNLESS OTHERWISE INDICATED.
2. ALL VOLTAGE TESTS MADE WITH ANALYZER OF TEST SET I-56-A AND ASSOCIATED TEST CORDS BETWEEN TEST POINT AND GROUND EXCEPT WHERE VOLTAGE IS SHOWN AS MEASURED BETWEEN TWO TEST POINTS. USE HIGH VOLTAGE TEST CORD FOR VOLTAGES ABOVE 1,000 VOLTS.
3. ALL VOLTAGES SHOWN ARE OPERATING VOLTAGES WITH THE TRANSMITTER AT FULL POWER OUTPUT ON CHANNEL #1.
4. VOLTAGE AT K16 AND TERMINALS 13-14 WILL BE ACTUAL A.C. LINE VOLTAGE.

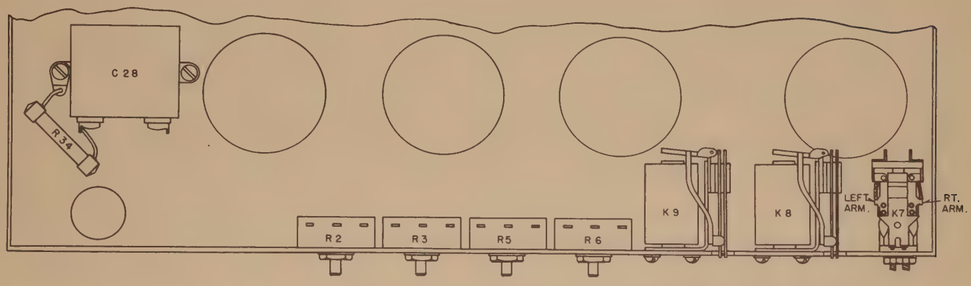
Figure 42. Power panel, voltage diagram.



FRONT PANEL

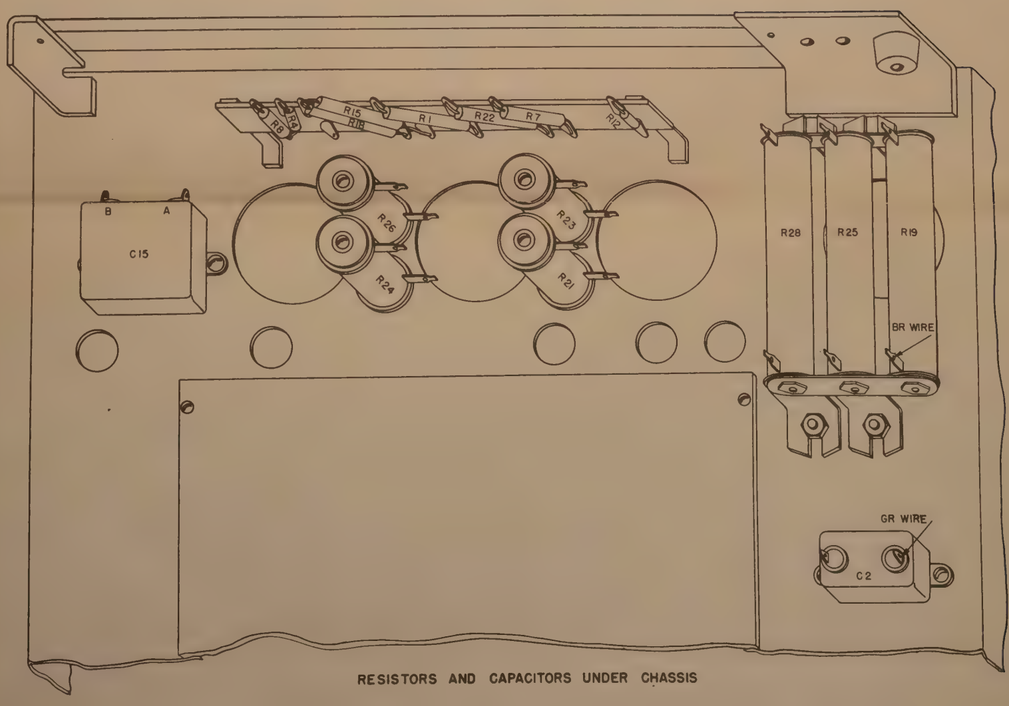


REAR PANEL



TOP VIEW OF REAR OF CHASSIS

TERMINAL STRIP



RESISTORS AND CAPACITORS UNDER CHASSIS

RESISTANCE VALUES — DRIVER PANEL

RESISTANCE VALUES - DRIVER PANEL

TERMINAL STRIP - SEE NOTES 1 TO 7

TEST POINT		METER RETURN		OHMS	REMARKS
APPARATUS	TERMINAL	APPARATUS	TERMINAL		
T83A	1	T83A	2	46	SWITCH S2 ON REMOTE.
T83A	2		GRD	∞	SWITCH S2 ON REMOTE.
T83A	3	T83A	20	140	SWITCH S2 ON REMOTE, R5 EXTREME CLOCKWISE POS.
T83A	3	T83A	20	240	SWITCH S2 ON REMOTE, R5 EXTREME COUNTER-CLOCKWISE POS.
T83A	4	TS3A	20	90	SWITCH S2 ON REMOTE, R6 EXTREME CLOCKWISE POS.
T83A	4	T83A	20	190	SWITCH S2 ON REMOTE, R6 EXTREME COUNTER-CLOCKWISE POS.
T83A	5	T83A	20	136	SWITCH S2 ON REMOTE, R3 EXTREME CLOCKWISE POS. - RELAY K2 IN JACK J2.
T83A	5	TS3A	20	1136	SWITCH S2 ON REMOTE, R3 EXTREME COUNTER-CLOCKWISE POS. - RELAY K2 IN JACK J2.
T83A	6	TS3A	7	136	RELAY K1 IN JACK J1.
T83A	7		GRD	∞	RELAY K1 IN JACK J1.
T83A	8	T83A	20	136	SWITCH S2 ON REMOTE, R2 EXTREME CLOCKWISE POS., RELAY K2 IN JACK J2.
T83A	8	T83A	20	1136	SWITCH S2 ON REMOTE, R2 EXTREME COUNTER-CLOCKWISE POS., RELAY K2 IN JACK J2.
T83A	9		GRD	200	
T83A	10		GRD	246	SWITCH S2 ON CHANNEL #1.
T83A	11	TS3A	20	1136	SWITCH S2 ON CHANNEL #1, RELAY K2 IN JACK J2.
T83A	11		GRD	0	SWITCH S2 ON CHANNEL #1, TEST KEY S4 OPERATED.
T83A	11		GRD	0	SWITCH S2 ON CHANNEL #1, HAND SET BUTTON OPERATED.
T83A	12		GRD	200	SWITCH S2 ON CHANNEL #1.
T83A	13		GRD	246	SWITCH S2 ON CHANNEL #1.
T83A	14		GRD	0	SWITCH S2 ON CHANNEL #1.
T83A	14	TS3A	20	140	SWITCH S2 IN OFF POS.
T83A	15	T83A	20	53	SWITCH S2 IN OFF POS.
T83A	15	T83A	20	73	SWITCH S2 IN OFF POS., INTERCONNECTING CABLE DISCONNECTED FROM TERM. #15.
T83A	15		GRD	0	SWITCH S2 ON CHANNEL #2.
T83A	16		GRD	0	SWITCH S1 ON PHONE-CW.
T83A	16		GRD	0	SWITCH S1 ON TWO-TONE.
T83A	16		GRD	5300	SWITCH S1 ON EXT. OSC.
T83A	17		GRD	63	SWITCH S1 ON PHONE-CW OR TWO-TONE, METER SWITCH S11 ON P.A. SPACE
T83A	18		GRD	0	NOT READABLE
T83A	19		GRD	0	
T83A	20		GRD	385	SWITCH S2 IN OFF POS. - INTERCONNECTING CABLE DISCONNECTED FROM TERM. #20.
T83B	21		GRD	0	
T83B	22		GRD	28	METER SWITCH S11 ON P.A. SPACE.
T83B	23		GRD	1240	
T83B	24		GRD	1268	METER SWITCH S11 ON P.A. SPACE.
T83B	25		GRD	1240	
T83B	25		GRD	20,000	INTERCONNECTING CABLE DISCONNECTED FROM TERM. #25.
	26		GRD	5030	
	28		GRD	∞	INTERCONNECTING CABLE DISCONNECTED FROM TERM. #28.

VACUUM TUBE TERMINALS

X1(6J5)	1 (SH)		GRD	0	
X1(6J5)	2 (H)		GRD	0	NOT MEASURABLE.
X1(6J5)	3 (P)	J2	5	15,000	SWITCH S1 ON PHONE-CW.
X1(6J5)	3 (P)	J2	5	15,000	SWITCH S1 ON TWO-TONE - OPERATE K4 PER NOTE 4.
X1(6J5)	4 (NC)		GRD	∞	
X1(6J5)	5 (G)		GRD	50,000	SWITCH S1 ON PHONE-CW.
X1(6J5)	6 (NC)		GRD	∞	
X1(6J5)	7 (H)		GRD	0	
X1(6J5)	8 (K)		GRD	0	
X2(802)	1 (H)		GRD	0	
X2(802)	2 (SH)		GRD	0	
X2(802)	3 (G2)	J2	5	15,000	
X2(802)	4 (G1)		GRD	10,080	
X2(802)	5 (G3)		GRD	1000	
X2(802)	6 (K)		GRD	1000	
X2(802)	7 (H)		GRD		NOT MEASURABLE
802	CAP (P)	R19	BR.WIRE	1	R31 EXTREME CLOCKWISE POS.
				10,000	R31 EXTREME COUNTER-CLOCKWISE POS.
				1	R32 EXTREME CLOCKWISE POS. - OPERATE K5 PER NOTE 4.
				10,000	R32 EXTREME COUNTER-CLOCKWISE POS. - OPERATE K5 PER NOTE 4.
X3(807)	1 (H)		GRD	0	
X3(807)	2 (G2)	R19	BR.WIRE	30,000	
X3(807)	3 (G1)	TS3B	25	10,080	
X3(807)	4 (K)		GRD	0	
X3(807)	5 (H)		GRD	0	NOT MEASURABLE.
807	CAP (P)	DRIVER PAN.	#28	6950	SWITCH S5 ON BAND "A"
				6600	SWITCH S5 ON BAND "B"
				5000	SWITCH S5 ON BAND "C"
				4900	SWITCH S5 ON BAND "D"
				6950	SWITCH S6 ON BAND "A" - OPERATE K6 PER NOTE 4.
				6600	SWITCH S6 ON BAND "B" - OPERATE K6 PER NOTE 4.
				5000	SWITCH S6 ON BAND "C" - OPERATE K6 PER NOTE 4.
				4900	SWITCH S6 ON BAND "D" - OPERATE K6 PER NOTE 4.
X4(VR75-30)	1		GRD	∞	
X4(VR75-30)	2 (K)		GRD	0	
X4(VR75-30)	3		GRD	∞	
X4(VR75-30)	4		GRD	∞	
X4(VR75-30)	5 (A)	DRIVER PAN.	#28	30,000	
X4(VR75-30)	6		GRD	∞	
X4(VR75-30)	7		GRD	∞	
X4(VR75-30)	8		GRD	∞	
X5(6H6)	1 (SH)		GRD	0	
X5(6H6)	2 (H)		GRD	0	NOT MEASURABLE
X5(6H6)	3 (P_2)	J1	1	11,000	SWITCH S1 ON TWO-TONE.
X5(6H6)	4 (K_2)		GRD	0	
X5(6H6)	5 (P_1)	J1	1	11,000	SWITCH S1 ON TWO-TONE.
X5(6H6)	6 (NC)		GRD	∞	
X5(6H6)	7 (H)		GRD	0	
X5(6H6)	8 (K_1)		GRD	0	

RELAY JACKS

J1	1	C2	GR.WIRE	1000	
J1	2		GRD	∞	
J1	3	TS3A	#7	0	
J1	4		GRD	5300	
J1	5	DRIVER PAN.	#38	30,000	
J1	6	TS3A	#6	0	
J1	7		GRD	∞	
J1	8		GRD	0	
J2	1		GRD	0	
J2	2	TS3A	#20	0	
J2	3		GRD	2000	
J2	4		GRD	∞	
J2	5	K7	LEFT ARM	15,000	R31 EXTREME CLOCKWISE.
J2	6	TS3A	#20	0	
J2	7	TS3A	#11	1000	SWITCH S2 ON CHANNEL #1.
J2	8		GRD	0	

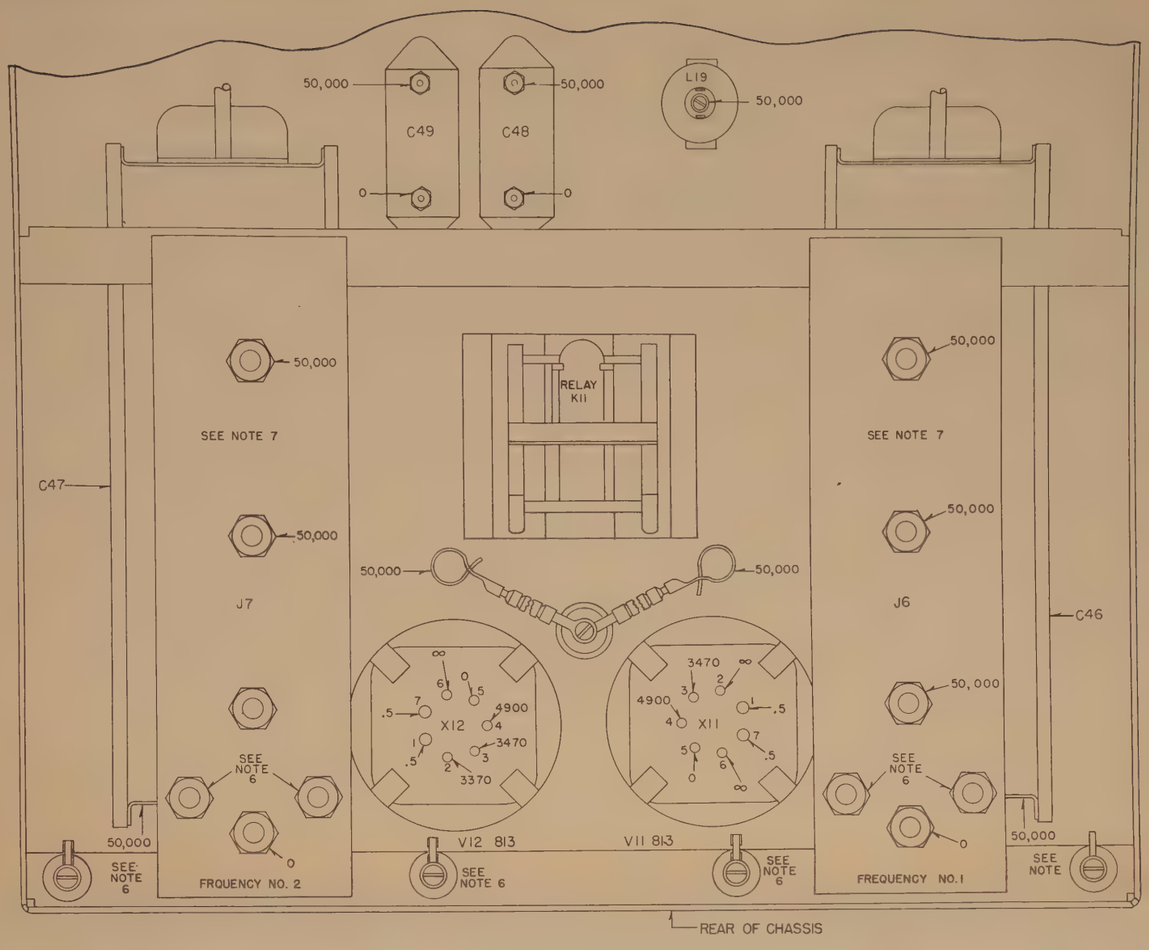
MISCELLANEOUS RESISTANCE POINTS

J3	TIP		GRD	100	

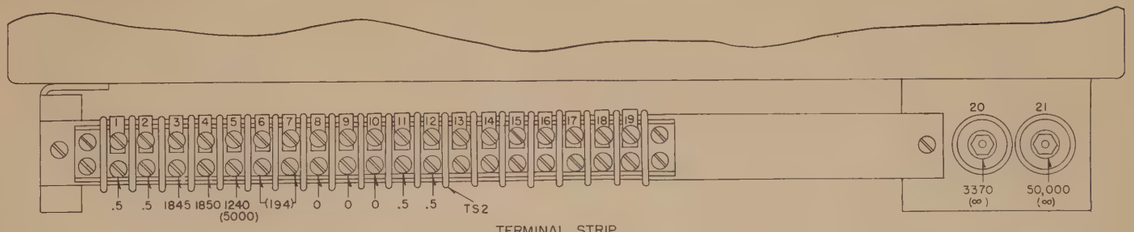
Figure 43. Driver panel, resistance diagram.

NOTES

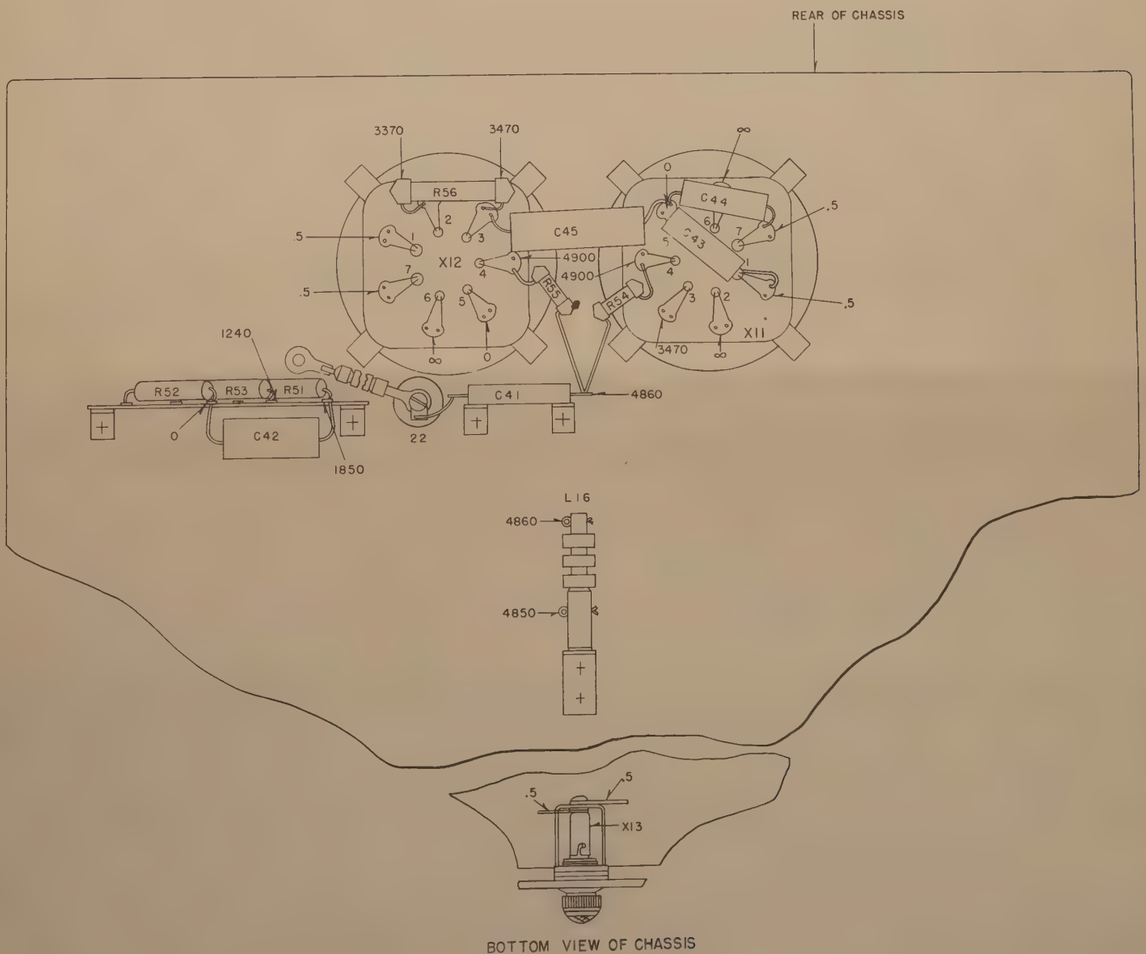
1. ALL RESISTANCE MEASUREMENTS MADE WITH ANALYZER OF TEST SET I-56-A
2. ALL RESISTANCE VALUES SHOWN ARE IN OHMS UNLESS OTHERWISE SPECIFIED.
3. INFINITY SYMBOL (∞) INDICATES OPEN CIRCUIT OR RESISTANCE TOO HIGH TO INDICATE ON TEST SET.
4. ALL RELAY, BIAS, FILAMENT AND PLATE POWER IS OFF WHILE MAKING RESISTANCE MEASUREMENTS EXCEPT FOR THOSE TESTS REQUIRING CHANNEL SWITCHING RELAYS TO BE OPERATED. IN CASES SO NOTED OPERATE THESE RELAYS BY TURNING S16 ON AND S2 TO REMOTE AND PLACING A GROUND ON DRIVER PANEL TERMINAL #4.
5. RELAYS K1 & K2 SHALL BE REMOVED FROM THEIR JACKS FOR ALL RESISTANCE TESTS UNLESS OTHERWISE SPECIFIED.
6. VACUUM TUBES ARE REMOVED FROM SOCKET BEING TESTED. ALL OTHER TUBES TO REMAIN IN PLACE.
7. ALL WIRING SHALL REMAIN CONNECTED FOR RESISTANCE TESTS EXCEPT WHERE IT IS NECESSARY TO ISOLATE A PARTICULAR PANEL FROM A COMMON LEAD AS COVERED BY REMARKS.



TOP VIEW OF CHASSIS



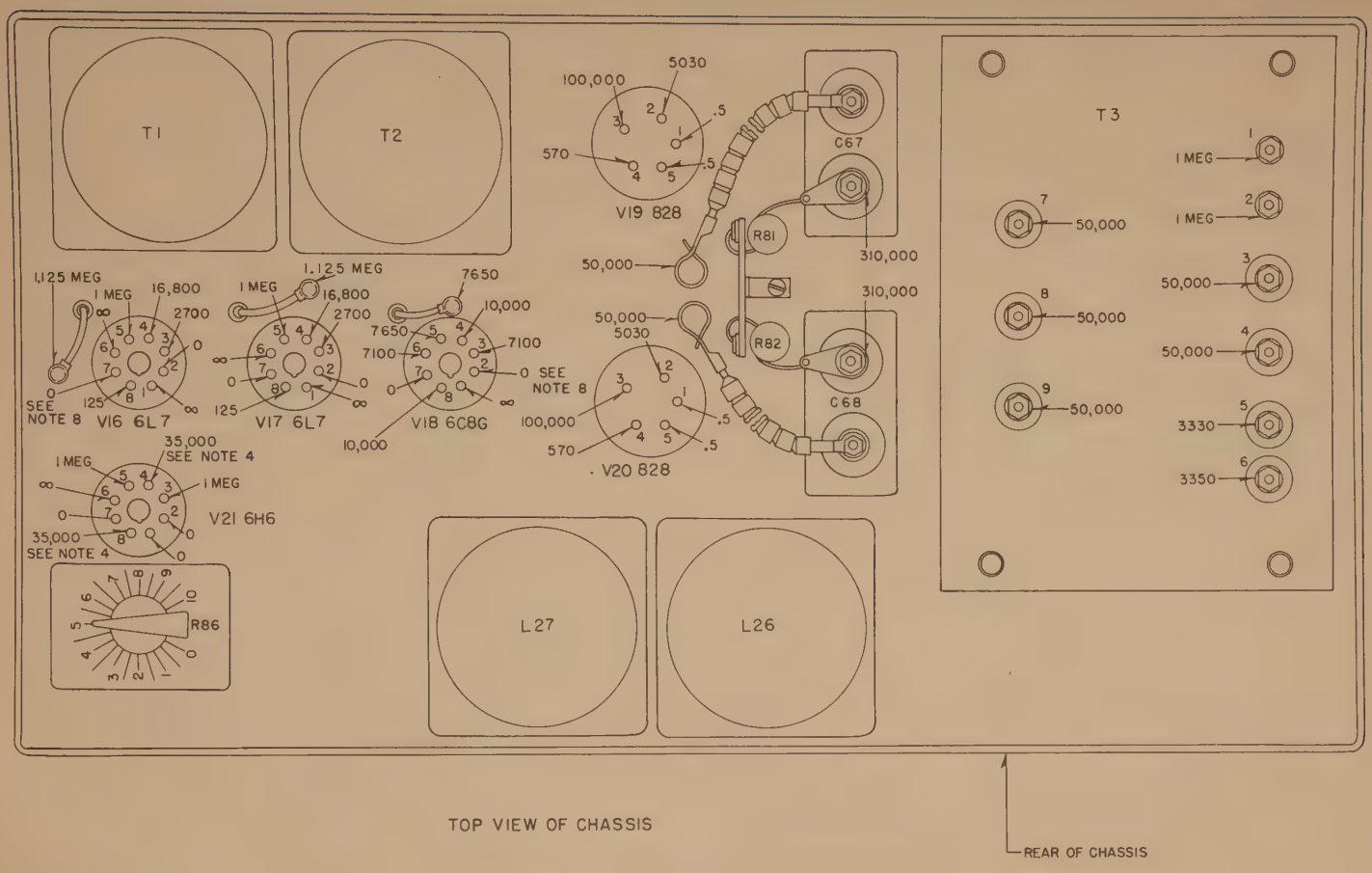
TERMINAL STRIP



BOTTOM VIEW OF CHASSIS

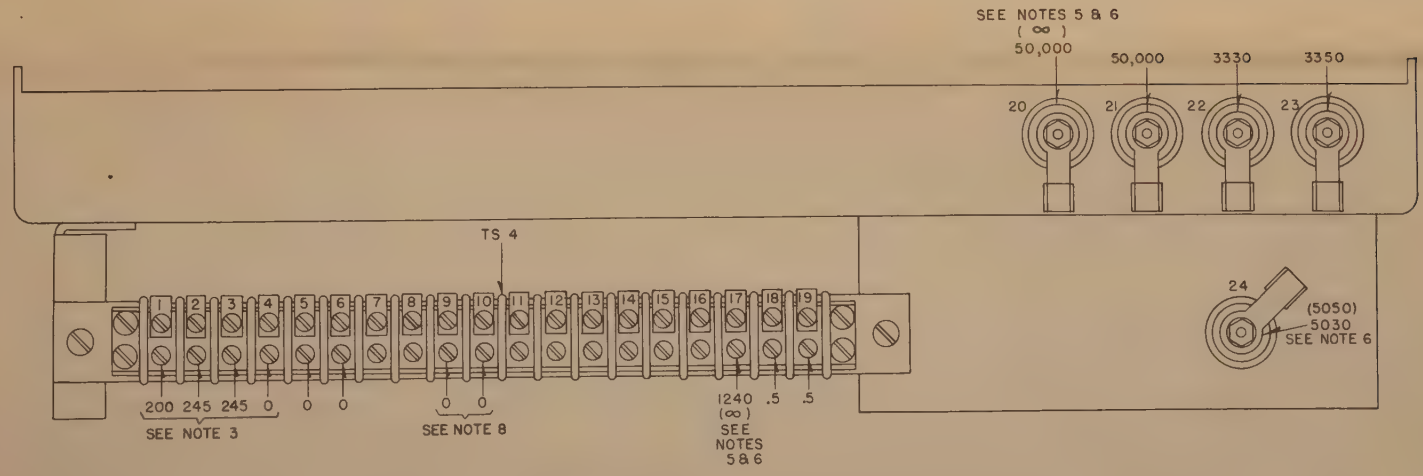
NOTES:
1. ALL RESISTANCE VALUES EXPRESSED IN OHMS.
2. ALL MEASUREMENTS MADE WITH ANALYZER OF TEST SET I-56A FROM TEST POINT TO GROUND EXCEPT AT TERMINALS NO. 6 & 7. USE RANGE WHICH GIVES A READING NEAR MIDSCALE IF POSSIBLE.
3. INFINITY SYMBOL (∞) INDICATES OPEN CIRCUIT OR RESISTANCE TOO HIGH TO INDICATE ON TEST METER.
4. TESTS MADE WITH ALL POWER OFF.
5. RESISTANCE VALUES IN BRACKET ( ) ARE MEASURED AT TERMINAL WITH INTERCONNECTING CABLE LEAD DISCONNECTED.
6. RESISTANCE AT ANTENNA TERMINALS IS DEPENDENT ON ANTENNA CIRCUIT IN USE.
7. PLUG IN COILS L17 & L18 ARE SHOWN OUT OF JACKS J6 & J7 FOR SAKE OF CLARITY. MAKE RESISTANCE MEASUREMENTS WITH COILS IN PLACE

Figure 44. R-f power amplifier panel, resistance diagram.

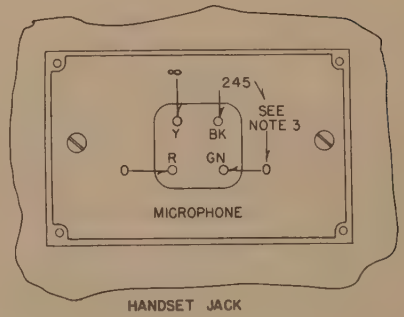


TOP VIEW OF CHASSIS

REAR OF CHASSIS



TERMINAL STRIP



HANDSET JACK

NOTES:

1. ALL RESISTANCE VALUES EXPRESSE IN OHMS UNLESS OTHERWISE INDICATED.
2. ALL RESISTANCE MEASUREMENTS MADE WITH ANALYZER OF TEST SET I-56-A FROM TEST POINT TO GROUND TERMINAL.
3. SET SWITCH S2 ON CHANNEL NO. 1 AND OPERATE TEST KEY S4. MAIN POWER SWITCH S16 IS OFF.
4. RESISTANCE SHOWN FOR V21 TERMINALS NO. 4 & 8 IS OBTAINED WITH R86 SET ON NO. 8.
5. INFINITY SYMBOL (∞) INDICATES OPEN CIRCUIT OR RESISTANCE TOO HIGH TO MEASURE.
6. RESISTANCE VALUES IN PARENTHESES ( ) INDICATE VALUE MEASURED AT TERMINAL WITH INTERCONNECTING CABLE DISCONNECTED FROM THAT TERMINAL.
7. HANDSET OUT OF JACK.
8. THE RESISTANCE AT 6.3 V HEATER TERMINALS IS TOO LOW TO INDICATE ON TEST METER.

Figure 45. Audio panel, resistance diagram.

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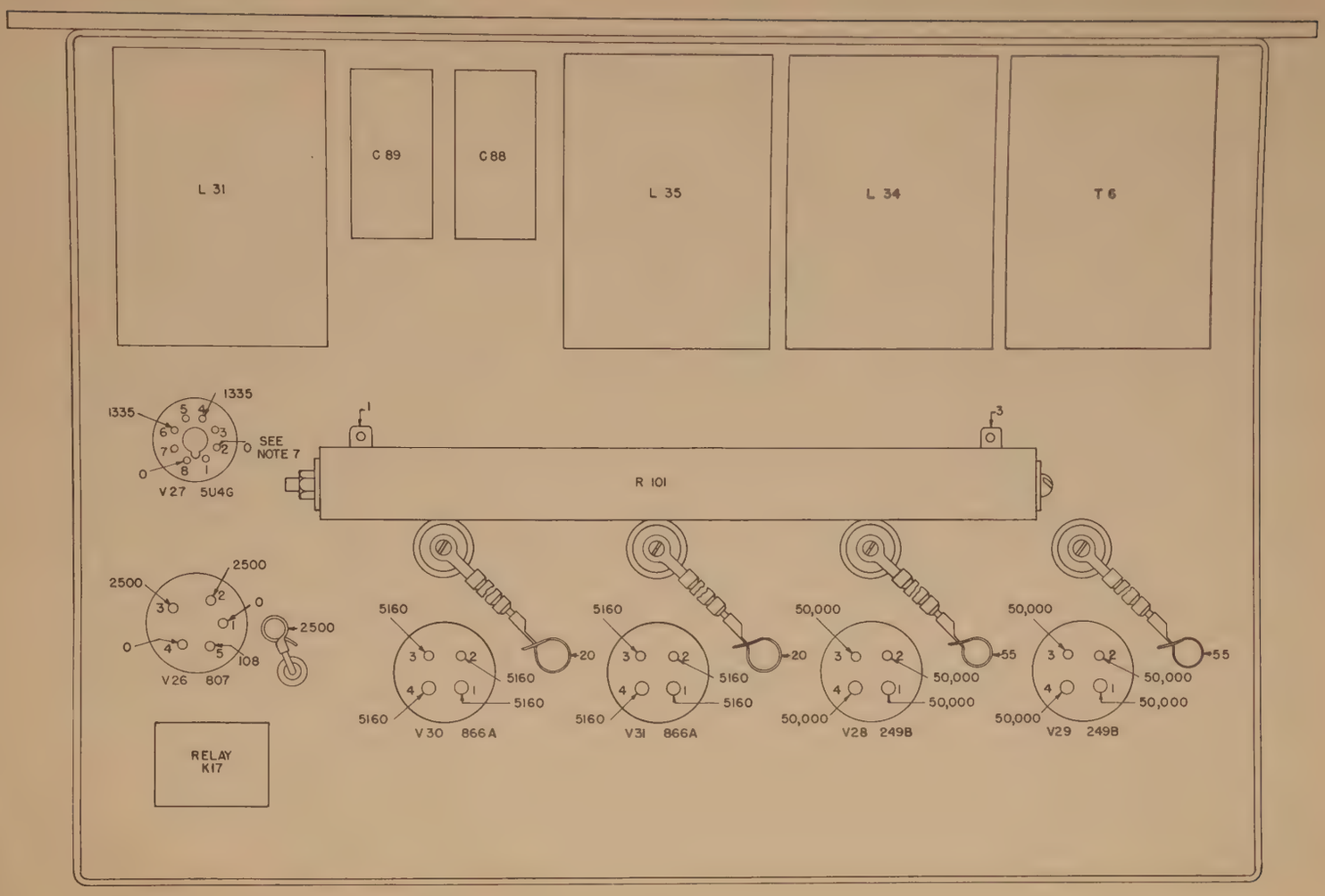
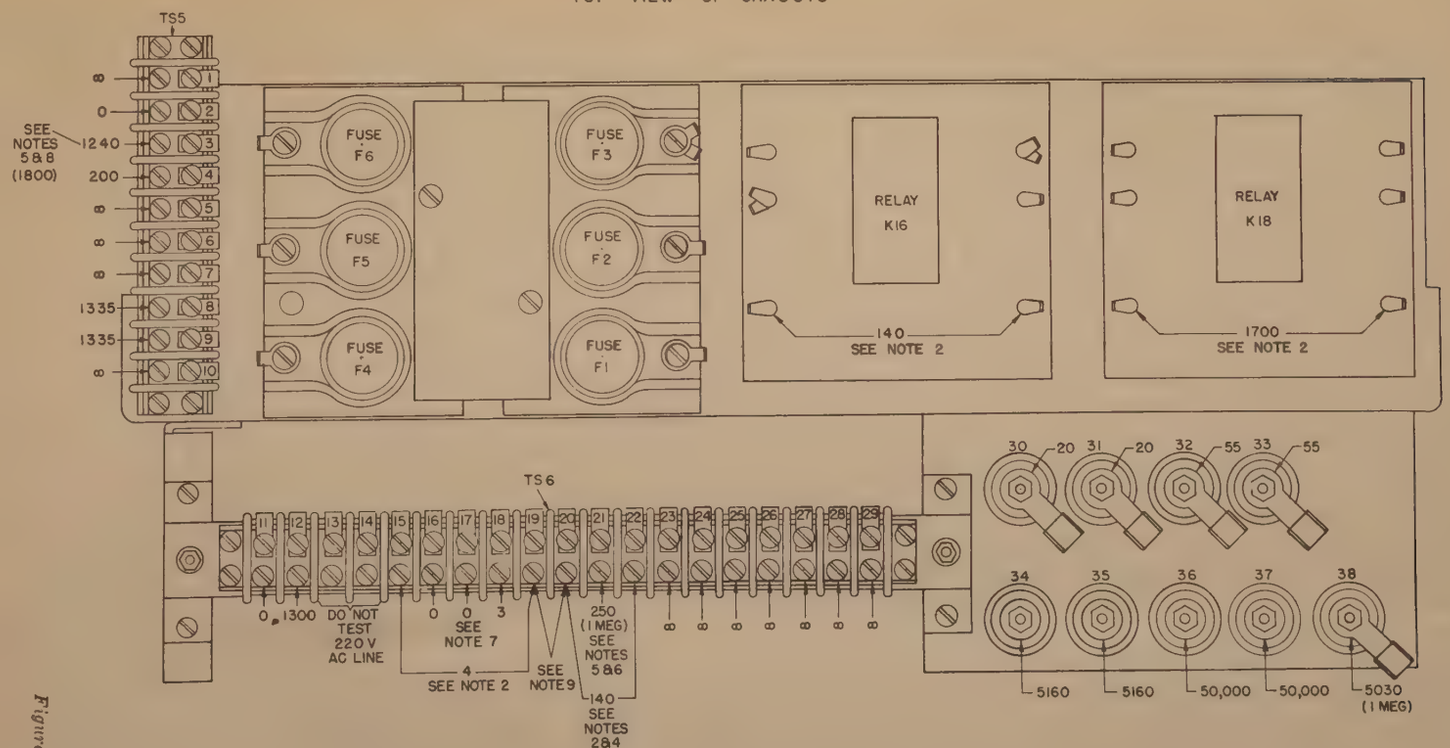


TOP VIEW OF CHASSIS



REAR VIEW OF CHASSIS

NOTES:

1. ALL RESISTANCE VALUES ARE EXPRESSED IN OHMS UNLESS OTHERWISE INDICATED.
2. ALL TESTS MADE WITH ANALYZER OF TEST SET I-56-A BETWEEN TEST POINT AND GROUND USING RANGE WHICH GIVES READING NEAR MIDSCALE INSOFAR AS POSSIBLE. CHECK RESISTANCE BETWEEN TWO TEST POINTS WHERE SO INDICATED.
3. RESISTANCE TESTS AT TUBE SOCKET TERMINALS MADE WITH THAT TUBE OUT OF SOCKET AND ALL OTHER TUBES AND WIRING IN PLACE.
4. ALL TESTS MADE WITH SWITCHES S2 AND S16 IN OFF POSITION.
5. RESISTANCE VALUES SHOWN IN PARENTHESES ( ) ARE MEASURED AT TERMINAL WITH INTERCONNECTING CABLE LEAD DISCONNECTED.
6. INFINITY SYMBOL (∞) INDICATES OPEN CIRCUIT OR RESISTANCE TOO HIGH TO INDICATE ON TEST METER.
7. RESISTANCE TOO LOW TO INDICATE ON TEST METER.
8. TRY REVERSING METER TEST LEADS AND TAKE HIGHEST READING.
9. RESISTANCE SUBJECT TO WIDE VARIATION.

Figure 46. Power panel, resistance diagram.

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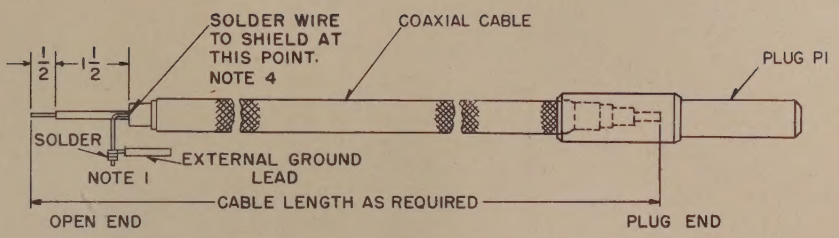
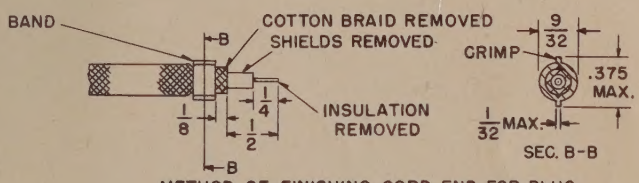
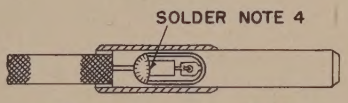


NOTES:

1. THE OUTER BRAID ON THE OPEN END SHOULD BE PULLED DOWN TO COVER THE END OF THE SHIELD AND SHOULD BE HELD IN PLACE BY MEANS OF CABLE BUTT LACQUER OR BY FRICTION TAPE. THE SPLICE, INCLUDING THE EXPOSED PORTION OF THE INTERNAL SHIELD GROUND WIRE, SHOULD BE PROTECTED BY FRICTION TAPE.
2. THE CORD SHALL BE CONNECTED TO THE PLUG BY THREADING THE BARE CONDUCTOR THROUGH THE HOLE OF THE TERMINAL. THE END OF THE CONDUCTOR SHALL BE BENT BACK TOWARD THE CORD.
3. THE BAND, SHALL BE SLIGHTLY UNDERFLUSH IN RELATION TO PLUG BODY.
4. SOLDER SHALL BE HEATED SO THAT IT WILL FLOW INTO SHIELD.

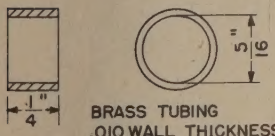


METHOD OF FINISHING CORD END FOR PLUG



METHOD OF ATTACHING PLUG

ENLARGED VIEW OF BAND



BRASS TUBING
.010 WALL THICKNESS

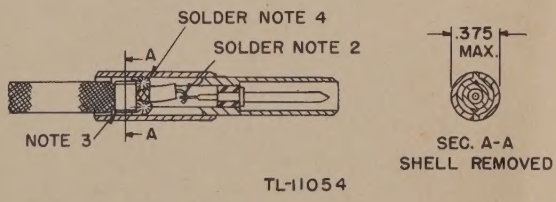


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Figure 47. Method of terminating shielded cable N1.

Order No. 16616-Phila.-43; 1850 copies, January 1945